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INSECTICIDE INDUCED RESURGENCE STUDY OF WHITEFLY IN COTTON AND TOMATO

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ABSTRACT

Whitefly the tiny aleyrodid becomes the most notorious pest during past decades. High selection pressure and wide host range induced the insect to emerge more ferociously. The objective of this paper is to explore the effect of insecticides at lethal and sub-lethal dose on the population resurgence of whitefly infesting cotton and tomato. Field experiment was thereby conducted during rabi season of 2012-13 and 2013-14 to evaluate twelve insecticidal treatments along with an untreated control. No resurgence was noted after the application of insecticides at recommended dose in both the crop, but at sub recommended dose resurgence of population was noted in imidacloprid treated plots in both the crop (+2.02% & +9.84%). Upsurgence of population was also noted in dinotefuran and clothianidin treated plots. Tank mix of spiromesifen + imidacloprid was recorded lowest resurgence at its recommended dose (-99.22% & -97.74%), while at sub recommended dose sole use of spiromesifen recorded lowest (-80.90% & -73.54%).

1. INTRODUCTION

"3 R" i.e. resistance, resurgence and residue are the most three serious headache in agro ecosystem. Though the issues raised in Silent Spring by Rachel Carson against the ill effect of broad spectrum insecticides; but still no other potent foreseeable pest management option is available with us other than chemical pesticide. Being able to produce quick knock down effect chemical pesticides are the most dependable weapon to tone down pest incidence. To tone down the pest damage farmers are using different chemical at improper dose in field condition. The chaotic uses of unauthentic insecticides either under dosing or over dosing, improper applications, repeated uses of single class of insecticide lead to the development of resistance against most of the commonly used insecticides through natural selection procedure [1, 2, 3]. Pest Resurgence is one of the important phenomenons related to abuse of pesticides [4] and can be linked to elimination of its predators and other natural enemies. Loss of predator species can also lead to a related phenomenon called secondary pest outbreaks [4]. In both pest resurgence and secondary outbreaks, their natural enemies were more susceptible to the pesticides than the pests themselves, in some cases causing the pest population to be higher than it was before the use of pesticide [4]. Cotton (Gossypium hirsutum L.) is an important cash crop of India. No other cultivated crop species so far reported is as susceptible as cotton to insect pests the world over. On the other hand tomato (Lycopersicon esculentum L.) is the most popular solanaceous vegetable globally. A complex of sucking pests and lepidopteran caterpillar used to infest the crop though out their growth stages [5]. Among these insect pests, whitefly Bemisia tabaci (Genn.) (Homoptera: Aleyrodidae) emerged as the most very destructive pest worldwide [6]. Acute crop loss in the areas of Andhra Pradesh, Tamil Nadu and Karnataka has been reported by

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David et al., [7]. Insecticide induced resurgence and resistance is now serious issue to whitefly control and has been reported in many countries including India. Therefore, in order to assure the effect of new generation insecticides regarding whitefly management, it is essential to study the resurgence phenomena due to lethal and sub-lethal dose.

2. MATERIALS AND METHODS

Field experiments were conducted in C-Block Farm, B.C.K.V., Kalyani, Nadia, West Bengal, which is located at 22.580N latitude, 88.260E longitude and 11m above MSL. The experiments were conducted during rabi season, 2012 and 2013 in randomised block design (RBD) with three replications for each treatment. Eight insecticides viz. Dinotefuran 20% SG (Token by Indofil Industries Ltd.), Sulfoxaflor 24% SC (sample given by Dow Agro Science), Buprofezin 25% SC (Bipimain by Makhteshim Agan India Pvt. Ltd.), Spiromesifen 24% SC (Oberon by Bayer Crop Sci.), Imidacloprid 200 SL (Confidor by Bayer Crop Science), Chlothianidin 50% WDG (Dantop by Sumitomo Chemical Takeda Agro Co. Ltd.), Flupyradifurone 200 SL (not registered sample give by Bayer Crop Science) and Flonicamid 50 % WG (Ullala by United Phosphorus Limited) and four tank mix insecticides viz. Dinotefuran+ Buprofezin, Sulfoxaflor+ Buprofezin, Spiromesifen+ Imidacloprid and Flonicamid + Buprofezin (for tank mixing of the insecticide chemistry the author underwent compatibility test considering different parameters like sedimentation, flocculation and separation. The tank mix in question passed the total compatibility test procedure and thus was accepted in treatment schedule) tested under field condition. Cotton (Bollguard II) and tomato (local variety determinate type) was raised in plots (12 sq m) under recommended package of practices with of 50 cm x 50 cm spacing. When the population of whitefly crosses conventional recommended ETL (economic threshold level) (150 adults/100leaf) [8], the insecticides were imposed with pneumatic knapsack sprayer with hollow cone nozzle at recommended and sub lethal doses diluted in 500 litres/ha of water. After each spray each plot was covered with insect proof net (40 mesh) to restrict the movement of insect from one plot to another. Mean number of whitefly adults per three leaves (one from each upper, middle and lower leaf) of five randomly selected plants were observed before and 10 days after each spray. Per cent resurgence was calculated using Henderson and Tilton (1955) formula after modification by Jayaraj and Regupathy [9],

$$\% \text{ resurgence} = \left(\frac{T_S}{C_S} \times \frac{C_F}{T_F} - 1\right) \times 100$$

[Where, TF = infestation in the treated plot during first count, TS = infestation in the treated plot during subsequent count, CF = infestation in the untreated control plot during first count, CS = infestation in the untreated control plot during subsequent count]

3. RESULTS

3.1 Effect of insecticides induced resurgence of whitefly population in cotton:

The pooled result of two season shows that no resurgence was occurred at recommended doses as the calculated value of resurgence occurrence (%) was negative. The percentage of resurgence was lowest in spiromesifen+imidacloprid (-96.24%) after first spray followed by spiromesifen (-94.81%), flupyradifurone (-93.96%), whereas, highest in dinotefuran (-65.57%) and sulfoxaflor (-73.92%). After the second spray the magnitude of resurgence was reduced than first spraying which was ranged from (-) 79.78% to (-) 99.22%. Highest percentage was recorded in dinotefuran and lowest was recorded in spiromesifen + imidacloprid; closely followed by flupyradifurone (-98.59%), sulfoxaflor+buprofezin (-97.47%), spiromesifen (-96.82%), flonicamid+ buprofezin (-96.08%), imidacloprid (-94.02%), buprofezin (-93.99%), dinotefuran+ buprofezin (-93.95%), flonicamid (-92.25%), clothianidin (-92.10%), sulfoxaflor (-87.05%). Surprisingly it was noticed that when the insecticides were sprayed below recommended dose the chance of resurgence increased. Positive values indicate the resurgence of population (Table-1).

Table 1: Effect of insecticides on resurgence of whitefly (*Bemisia tabaci*) in cotton (Pooled)

Treatment	Dose (g a.i./ha)	T_F	C_F	1st spray			2nd spray		
				T_S	C_S	% resurgence	T_S	C_S	% resurgence
Dinotefuran 20 SG	80	11.97		4.45		-65.57	2.88		-79.78
Sulfoxaflor 24 SC	50	12.00	12.89	3.38	13.92	-73.92	1.85	15.34	-87.05
Buprofezin 25 SC	200	12.45		1.11		-91.74	0.89		-93.99

Imidacloprid 17.8 SL	50	13.50		1.54		-89.44	0.96		-94.02
Spiromesifen 24 SC	120	12.67		0.71		-94.81	0.48		-96.82
Clothianidin 48 WDG	50	11.80		1.77		-86.11	1.11		-92.10
Dinotefuran+ Buprofezin	(20+150)	13.20		2.69		-81.13	0.95		-93.95
Sulfoxaflor+ Buprofezin	(25+150)	12.61		1.38		-89.87	0.38		-97.47
Flonicamid 50 WG	50	12.90		2.11		-84.85	1.19		-92.25
Flonicamid + Buprofezin	(25+150)	12.86		1.14		-91.79	0.60		-96.08
Flupyradifurone 200 SL	200	11.95		0.78		-93.96	0.20		-98.59
Spiromesifen+ Imidacloprid	(60+30)	11.83		0.48		-96.24	0.11		-99.22

After first spray per cent resurgence was lowest in spiromesifen (-) 69.60%, whereas imidacloprid showed (+) 0.63% resurgence followed by (-) 2.46% in clothianidin and (-) 7.48% in dinotefuran. After second spraying the percentage of resurgence was increased at (+) 2.02% in imidacloprid and spiromesifen+imidacloprid (-58.94%) treated plot whereas, percentage of resurgence decreased in all other treatments; spiromesifen (-80.90%) recorded the lowest resurgence followed by flonicamid+buprofezin (-77.00%) and sulfoxaflor+buprofezin (-74.41%) (Table-2).

Table 2: Effect of insecticides at sub-lethal dose on resurgence of whitefly (*Bemisia tabaci*) in cotton (Pooled)

Treatment	Dose (g a.i./ha)	T_F	C_F	1st spray			2nd spray		
				T_S	C_S	% resurgence	T_S	C_S	% resurgence
Dinotefuran 20 SG	40	11.97	12.89	11.96	13.92	-7.48	12.25	15.34	-14.01
Sulfoxaflor 24 SC	25	12.00		7.71		-40.50	8.34		-41.60
Buprofezin 25 SC	100	12.45		4.79		-64.37	4.56		-69.22
Imidacloprid 17.8 SL	25	13.50		14.67		+0.63	16.39		+2.02
Spiromesifen 24 SC	60	12.67		4.16		-69.60	2.88		-80.90
Clothianidin 48 WDG	25	11.80		12.43		-2.46	12.43		-11.49
Dinotefuran+ Buprofezin	(10+75)	13.20		6.23		-56.30	6.34		-59.64
Sulfoxaflor+ Buprofezin	(12.5+75)	12.61		5.21		-61.74	3.84		-74.41
Flonicamid 50 WG	25	12.90		8.18		-41.28	6.08		-60.40
Flonicamid + Buprofezin	(12.5+75)	12.86		5.48		-60.54	3.52		-77.00
Flupyradifurone 200 SL	100	11.95		5.72		-55.68	3.65		-74.33
Spiromesifen+ Imidacloprid	(30+15)	11.83		5.11		-60.00	5.78		-58.94

3.2 Effect of insecticides induced resurgence of whitefly population in tomato:

The impact of insecticides on resurgence of whitefly population is depicted in table-3 & 4. In tomato the percentage of resurgence values were also recorded negative in all the treated plots when the insecticides were sprayed in recommended dose while negative value was recorded in below recommended dose of insecticides under test. The percentage of resurgence after first spray was lowest in spiromesifen+imidacloprid (-95.65%) followed by flonicamid+buprofezin (-91.75%), flupyradifurone (-91.47%), whereas, highest in dinotefuran (-51.98%) followed by sulfoxaflor (-75.14%). After the second spray the magnitude of resurgence was reduced than first spray which was ranged to the tune of (-) 68.17% to (-) 97.74%. Highest percentage was recorded in dinotefuran and lowest was recorded in spiromesifen+imidacloprid; closely followed by flupyradifurone (-97.17%), flonicamid+buprofezin (-96.74%), spiromesifen (-96.34%), sulfoxaflor+buprofezin (-93.89%), dinotefuran+buprofezin (-92.88%), buprofezin (-91.78%), clothianidin (-89.28%), sulfoxaflor (-88.80%), flonicamid (-88.74%) and imidacloprid (-76.89%) (Table 3)
.

Table 3: Effect of insecticides on resurgence of whitefly (*Bemisia tabaci*) in tomato (Pooled)

Treatment	Dose (g a.i./ha)	T_F	C_F	1st spray			2nd spray		
				T_S	C_S	% resurgence	T_S	C_S	% resurgence
Dinotefuran 20 SG	80	7.00	7.34	4.03	8.80	-51.98	3.06	10.08	-68.17
Sulfoxaflor 24 SC	50	7.28		2.17		-75.14	1.12		-88.80
Buprofezin 25 SC	200	7.00		1.36		-83.79	0.79		-91.78
Imidacloprid 17.8 SL	50	7.12		1.88		-77.98	2.26		-76.89
Spiromesifen 24 SC	120	6.77		0.74		-90.88	0.34		-96.34
Clothianidin 48 WDG	50	7.13		1.34		-84.32	1.05		-89.28
Dinotefuran+ Buprofezin	(20+150)	7.26		1.18		-86.44	0.71		-92.88
Sulfoxaflor+ Buprofezin	(25+150)	7.15		1.21		-85.88	0.60		-93.89
Flonicamid 50 WG	50	6.79		1.59		-80.47	1.05		-88.74
Flonicamid + Buprofezin	(25+150)	7.38		0.73		-91.75	0.33		-96.74
Flupyradifurone 200 SL	200	6.94		0.71		-91.47	0.27		-97.17
Spiromesifen+ Imidacloprid	(60+30)	7.09		0.37		-95.65	0.22		-97.74

Imidacloprid at its sub normal dose recorded (-) 18.70% resurgence followed by (-) 23.03% in dinotefuran and (-) 28.38% in flonicamid, whereas, flonicamid+buprofezin recorded the lowest per cent resurgence (-58.07) after first spraying. After second spraying it was noticed that the population showed positive resurgence (+) 9.84% over control in imidacloprid treated plots; dinotefuran also showed positive trend of resurgence (-13.14%). Spiromesifen recorded the lowest resurgence (-73.54%) followed by flonicamid+buprofezin (-68.13%) after second spray (Table 4)

Table 4: Effect of insecticides at sub-lethal dose on resurgence of whitefly (*Bemisia tabaci*) in tomato (Pooled)

Treatment	Dose (g a.i./ha)	T_F	C_F	1st spray			2nd spray		
				T_S	C_S	% resurgence	T_S	C_S	% resurgence

Dinotefuran 20 SG	40	7.00		6.46		-23.03	8.35		-13.14
Sulfoxaflor 24 SC	25	7.28		4.78		-45.23	4.14		-58.59
Buprofezin 25 SC	100	7.00		3.73		-55.55	3.26		-66.09
Imidacloprid 17.8 SL	25	7.12		6.94		-18.70	10.74		+9.84
Spiromesifen 24 SC	60	6.77		3.44		-57.62	2.46		-73.54
Clothianidin 48 WDG	25	7.13	7.34	5.34	8.80	-37.53	8.02	9.79	-18.09
Dinotefuran+ Buprofezin	(10+75)	7.26		4.02		-53.81	4.27		-57.17
Sulfoxaflor+ Buprofezin	(12.5+75)	7.15		4.44		-48.20	4.04		-58.86
Flonicamid 50 WG	25	6.79		5.83		-28.38	4.36		-53.24
Flonicamid + Buprofezin	(12.5+75)	7.38		3.71		-58.07	3.23		-68.13
Flupyradifurone 200 SL	100	6.94		4.10		-50.72	3.79		-60.23
Spiromesifen+ Imidacloprid	(30+15)	7.09		3.78		-55.53	5.36		-44.95

It is prominent from the experimental result depicted above that the test insecticides induced no resurgence at recommended dose. Only imidacloprid showed resurgence of whiteflies in both the crop when applied as sub lethal dose, while clothianidin and dinotefuran showed upsurge trend of whitefly population on 10 days after spraying; side by side except imidacloprid all the insecticides showed moderate to little toxicity towards whitefly and prevented resurgence of whitefly even at sub-lethal doses among them spiromesifen, flupyradifurone, sulfoxaflor+ buprofezin flonicamid+ buprofezin, spiromesifen+ imidacloprid and buprofezin were best. Although we are well acquainted that imidacloprid is a key insecticide, universally used for control sucking pest especially the homopterans, but extensive use of imidacloprid for suppressing whitefly has placed a heavy selection pressure on the target insect, which may be the cause of reduced efficacy and resurgence of population. Besides that sub lethal exposure to imidacloprid may be stimulated whitefly population growth by increasing fecundity or shortening development times. This phenomenon also might be attributed to diverse climatic, agronomic, biological or may be wide spread use of imidacloprid or insecticide related factors, whose relative importance is still poorly understood. There was a scanty of documentation regarding resurgence of whitefly. Our findings can be collaborated with the report made by Pirmoradi et al. [10], who reported lowest efficacy of imidacloprid against whiteflies. Reduced efficacy of imidacloprid was also reported by Golmohammadi et al. [11] in Bushehr province of Iran. The low efficacy of imidacloprid against adult whiteflies was reported to be due to emergence of resistant biotypes of whiteflies (Pirmoradi et al. 2001). Resistance of whiteflies to imidacloprid was also reported by Sheikhi [12]. Our experimental result contradicts with the outcome reported by Sethi and Dilawari [13], who opined that whitefly populations did not show any resurgence against imidacloprid. Large scale use of imidacloprid during last six years in agriculture ecosystem to manage the whitefly and other sucking insects has placed a heavy selection pressure on the target insect may be the factor behind this contrary. From our present findings it can be concluded that repeated use of imidacloprid should be checked immediately and never to use at its sub-lethal dose. Efficacy of dinotefuran over whitefly is quite low in respect of other treatments, which contradicts with the report showed by Palumbo [14]. Bethke and Byrne [15] reported that dinotefuran heavily favoured for the control of whiteflies. As this 3rd generation neonicotinoid was registered recently very few findings were reported. Low dose of dinotefuran may be associated with this contrary; further research should be conducted with dinotefuran at different doses to achieve a conclusion.

4. CONCLUSION

From the above experiment it can be concluded that the test insecticides along with some tank mixed insecticides at recommended dose induced no resistance, though due to high exposure towards neo-nicotinoid insecticides induced upsurgence of population at below recommended dose. Imidacloprid was noted as the only insecticide that can induce resurgence of whitefly population to some extent at below recommended dose.

5. CONFLICT OF INTEREST

All authors have declared that there is no conflict of interest regarding publication of this article.

6. ACKNOWLEDGEMENT

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