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Relative toxicity of certain insecticide against the field population of spiralling whitefly, *Aleurodicus disperses* Russell and its management

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ABSTRACT: Adults of spiralling whitefly, *Aleurodicus disperses* (Hemiptera: Aleyrodidae) were collected from three different locations *viz*, field with no pesticide application (location I), field where insecticides were applied and control failure were also observed (location II) and field where insecticides were applied but with no known reports of control failure (location III). Three insecticides quinalphos 25% EC @ 250 g a.i ha^{-1}, fenvalerate 20% EC @ 25 g a.i ha^{-1} and imidacloprid 17.8% SL @ 20 g a.i ha^{-1}at seven different concentrations were selected to test the resistance/ susceptibility of the populations. Population collected from location-II showed resistance with resistance ratio of 2.60, 2.90 and 1.85 and population from location-III showed resistant ratio of 1.14, 1.62 and 1.28 against quinalphos, fenvalerate and imidacloprid respectively. The resistant population was effectively managed by new generation insecticides, thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC @ 33+ 15.75 g a.i ha^{-1}, clothianidin 50% WDG @ 20 g a.i ha^{-1} and flonicamid 50% WG @ 75 g a.i ha^{-1}at laboratory experiments. Higher mortality of whitefly was observed with thiamethoxam 12.6% +lambda cyhalothrin 9.5% ZC @ 33+15.75 g a.i ha^{-1} under field conditions.

Keywords: Insecticide resistance, *Aleurodicus dispersus*, New generation insecticides, Bioassay

INTRODUCTION

India is facing a threat due to the accidental introduction of many exotic pest species which has the higher potential to drown agrarian ecosystem. The spiralling whitefly, *Aleurodicus dispersus* Russell (Hemiptera: Aleyrodidae) is one such introduction that has shattered the agricultural production system and has forced the farmers to use insecticides irrationally (Kodandaram *et al*., 2016). It was considered as a neglected pest but in recent years it has attained the status of major pest due to its wider host range. In India, 253 plant species of 176 genera and 60 families are accounted as the host of this exotic pest (Srinivasa, 2000). The major host plants of economic concern are guava, banana, tapioca, coconut, tomato, mulberry, avocado, cucurbits, papaya, gerbera, dahlia, gladiolus and bell pepper where 80% crop loss was observed in guava in Taiwan (Wen *et al*., 1995) and 53.10% in tapioca in India (Geetha, 2000). Farmers used to spray different insecticides including non-recommended ones with varying doses against this pest. Excessive dependence on insecticides has resulted in resistance, ecological disturbances and higher cost to the growers. Comparing resistance levels in different location is a prerequisite while making decisions in insect pest management programme. Since insecticide resistance is increasing swiftly due to the continuous use of chemicals. Several research works have been carried out across the world on the insecticide resistance against *Bemisia tabaci* Gennadius (Kranthi *et al*., 2002). However, the published works on insecticide resistance in spiralling whitefly, *A. dispersus* are so meagre even though they are causing severe damage in many crops especially vegetables. Aim of this study was therefore assess the extent of insecticide resistance in the field population of spiralling whitefly, *Aleurodicus dispersus.*

MATERIALS AND METHODS

Assessment of relative toxicity of insecticides against field populations of spiralling whitefly *A. dispersus* on tomato

Adults of spiralling whitefly, *A. dispersus* were collected from three different locations- Sreekaryam (Location-I) situated at 8^{0}54' N latitude and 76^{0}92' E longitude, College of Agriculture, Vellayani (Location-II) situated at 8^{0}43' N latitude and 76^{0}98' E longitude and farmer's field at Kalliyoor (Location- III)) situated at 8^{0}43' N latitude and 77^{0}01' E longitude. The first population was taken from a field with no pesticide application (Location I). The second population was from a field where insecticides were applied and control failures were also observed (Location II) and the third population was taken from field with insecticide application and no control failure (Location III). Seven doses of three insecticides quinalphos25% EC @ 250 g a.i ha^{-1} (organophosphate- Acetylcholine esterase (AChE) inhibitor) (0.02, 0.03, 0.04, 0.05, 0.06, 0.07, 0.08 %), fenvalerate20% EC @ 25 g a.i ha^{-1}(sodium channel modulator)(0.0013, 0.0025, 0.005, 0.01, 0.02, 0.03, 0.04 %) and imidacloprid 17.8% SL @ 20 g a.i ha^{-1} (Neonicotinoid- nicotinic acetylcholine receptor (nAChR) competitive modulator) (0.002, 0.003, 0.004, 0.005, 0.006, 0.007, 0.008 %) from three varying groups with different mode of action was selected to test the resistance/ susceptibility of the populations.

Tomato seedlings were raised without applying any insecticides. Leaf dip method was followed for conducting bioassay (Sreelakshmi, 2017). The design used was CRD with 22 treatments (three insecticides, each at seven different concentrations + control) and three replications. A series of concentrations of each commercial insecticide was prepared in aqueous solution and the tomato leaves were dipped for 25 seconds in each treatment and shade dried. After proper drying, the leaves were placed in plastic jars and twenty adult whiteflies from each location were released. Leaves dipped in water were considered as the control. Mortality was noted after 0.8, 1, 3, 6, 12 and 24 hours after treatment and was confirmed by probing the adult whiteflies with soft camel hair brush. Whiteflies failing to show coordinated forward movement were considered dead. Abbott's formula (Abbott, 1925) was used to calculate the percentage mortality.

The observed mortality was used to calculate relative toxicity to these chemicals in terms of LC_{50} and LC_{90}. Toxicity values LC_{50} and LC_{90} were calculated using probit analysis (Finney, 1971). The population showing the lowest LC_{50} was considered as susceptible population (reference strain) and the resistance ratio was calculated by the equation shown below. Further study was carried out using the resistant population.

$$\text{Resistance ratio} = \frac{LC_{50}/ LC_{90} \text{ of resistance population}}{LC_{50}/LC_{90} \text{ of Susceptible population}}$$

(Sreelakshmi, 2017)

Evaluation of efficacy of new generation insecticides against the population of *A. dispersus* under laboratory condition

Population of *A.dispersus* which was found resistant to three insecticides were used for the evaluation of new generation insecticides. Seven insecticides*viz*., buprofezin 25% SC @ 75 g a.i ha^{-1}, clothianidin 50% WDG @ 20 g a.i ha^{-1}, cynantraniliprole 10.26% OD @ 90 g a.i ha^{-1}, dinotefuran 20% SG @ 25 g a.i ha^{-1}, floni camid 50% WG @ 75 g a.i ha^{-1}, thiamethoxam 25% WG @ 50 g a.i ha^{-1}, thiamethoxam 12.6% +lambda cyhalothrin 9.5% ZC @ 33+15.75 g a.i ha^{-1}were tested against the resistant population at recommended dose to find its efficacy.The laboratory evaluation was done as in the above experiment with design CRD, treatments 8 and replication 3with 20 insects in each replication and mortality was noted after 0.25, 0.5, 0.75, 1, 1.25 and 1.5 HAT. Percentage mortality was calculated using Abbott's formula (Abbott, 1925)

Field evaluation of selected new generation insecticides against population of whiteflies

Three effective insecticides were further tested in field with treatments 4 and replications 5- design RBD, to test their efficacy in managing the relatively resistant population of *A.dispersus*.

Table 1. Toxicity of quinalphos to *A. dispersus* collected from three different locations at 0.8 hours after spraying

	LC_{50} (ppm)	Fiducial limits		LC_{90} (ppm)	Fiducial limits		χ^2	Slope ± SE	Resistance Ratio	
		Lower	Upper		Lower	Upper			LC_{50}	LC_{90}
Location I	35.39	27.53	41.13	103.31	93.42	129.52	0.18	7.17±0.003	1	1
Location II	92.11	77.49	126.99	208.74	159.62	336.32	0.88	4.38 ±0.003	2.60	2.02
Location III	40.65	34.85	45.43	106.78	91.91	121.45	2.19	8.11±0.002	1.14	1.03

$\chi2$ table value at 5 df = 11.07, $\chi2$ is non- significant at: $p< 0.05$

Table 2. Toxicity of fenvalerate to *A. dispersus* collected from three different locations at 0.8 hours after spraying

	LC_{50}	Fiducial limits		LC_{90}	Fiducial limits		χ^2	Slope ± SE	Resistance Ratio	
		Lower	Upper		Lower	Upper			LC_{50}	LC_{90}
Location I	8.01	1.68	13.76	48.08	39.62	82.04	8.79	7.84±0.004	1	1
Location II	23.23	19.81	27.52	66.97	56.68	86.46	4.19	8.18±0.004	2.90	1.39
Location III	12.94	10.13	15.62	52.03	41.93	57.09	7.48	9.69±0.004	1.62	1.08

$\chi2$ table value at 5 df = 11.07, $\chi2$ is non- significant at: $p< 0.05$

Table 3. Toxicity of imidacloprid to A. *dispersus* collected from three different locations at 0.8 hours after spraying

	LC_{50} (ppm)	Fiducial limits		LC_{90} (ppm)	Fiducial limits		χ^2	Slope ± SE	Resistance Ratio	
		Lower	Upper		Lower	Upper			LC_{50}	LC_{90}
Location I	3.54	2.75	4.11	10.67	9.34	12.95	0.179	7.174±0.028	1	1
Location II	6.54	5.86	7.54	14.99	12.54	19.67	0.409	6.16±0.025	1.85	1.40
Location III	4.53	3.91	5.08	11.95	10.34	14.73	0.036	7.016±0.024	1.28	1.11

$\chi2$ table value at 5 df = 11.07, $\chi2$ is non- significant at: $p< 0.05$

RESULTS AND DISCUSSION

Assessment of relative toxicity of insecticides against field populations of spiralling whitefly *A. dispersus* in tomato

Quinalphos

The lowest LC_{50} value of 35.39 ppm was observed for whitefly population from location I followed by location III (40.65ppm) and Location II (92.11ppm).The resistance ratio of LC_{50} values of whitefly population collected from Location II was 2.60 while in Location III population it was 1.14. Similarly, the resistance ratio calculated using LC_{90}, gave values *viz*. 2.02 and 1.03 from Location II and Location III respectively. Based on the LC_{50} and LC_{90} values, Location II population was comparatively resistant than population collected from Location I and Location III (Table 1)

Fenvalerate

The toxicity of fenvalerate to the populations of *A. dispersus* are shown in table 2. The highest LC_{50} value was shown by whitefly population gathered from location II (23.23ppm) and the lowest from location I (8.01ppm). While considering LC_{50} values, a resistance ratio of 2.90 was observed in case of population from Location II and 1.62 for Location III population. Resistance ratio obtained using LC_{90} values were 1.39 for population from Location II, 1.08 for population from Location III and 1 for Location I population. Based on the LC_{50} and LC_{90}values, Location II population showed more resistance to fenvalerate.

Imidacloprid

In case of imidacloprid, LC_{50} values were in the order 3.54 ppm for Location I population, 6.54 ppm for population from Location II and 4.53 ppm for Location

Table 4. Mortality of *A. dispersus* treated with new generation insecticides in laboratory condition

Treatment	Mortality (%)* HAT						
	0.25	0.5	0.75	1	1.25	1.5	1.75
Buprofezin 25% SC @ 75 g a.i ha^{-1}	1.67[cd]	5.00[d]	25.00[e]	28.33[e]	33.33[c]	58.33[b]	100.00[a]
	(4.72)	(10.66)	(29.92)	(32.01)	(35.16)	(49.83)	(89.37)
Clothianidin 50% WDG @ 20 g a.i ha^{-1}	26.67[b]	65.00[a]	80.00[b]	100.00[a]	100.00[a]	100.00[a]	100.00[a]
	(31.07)	(53.76)	(63.54)	(89.37)	(89.37)	(89.37)	(89.37)
Cynantraniliprole 10.26% OD @ 90 g a.i ha^{-1}	3.33[cd]	35.00[b]	41.67[d]	61.67[c]	100.00[a]	100.00[a]	100.00[a]
	(6.56)	(36.23)	(40.19)	(51.80)	(89.37)	(89.37)	(89.37)
Dinotefuran 20% SG @ 25 g a.i ha^{-1}	0.00[d]	16.67[c]	35.00[d]	68.33[c]	100.00[a]	100.00[a]	100.00[a]
	(0.62)	(26.45)	(36.24)	(55.77)	(89.37)	(89.37)	(89.37)
Flonicamid 50% WG @ 75 g a.i ha^{-1}	6.67[c]	36.67[b]	66.67[c]	78.33[b]	100.00[a]	100.00[a]	100.00[a]
	(12.12)	(37.20)	(54.83)	(62.29)	(89.37)	(89.37)	(89.37)
Thiamethoxam 25%WG @ 50 g a.i ha^{-1}	0.00[d]	1.67[de]	41.67[d]	45.00[d]	75.00[b]	100.00[a]	100.00[a]
	(0.62)	(4.72)	(40.19)	(42.13)	(60.07)	(89.37)	(89.37)
Thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC @ 33+15.75 g a.i ha^{-1}	45.00[a]	66.67[a]	100.00[a]	100.00[a]	100.00[a]	100.00[a]	100.00[a]
	(42.12)	(54.83)	(89.37)	(89.38)	(89.38)	(89.37)	(89.37)
Control (Water)	0.00[d]	0.00[e]	0.00[f]	0.00[f]	0.00[d]	0.00[c]	0.00[b]
	(0.62)	(0.62)	(0.62)	(0.62)	(0.62)	(0.62)	(0.62)
CD (0.05)	(10.445)	(8.811)	(4.777)	(4.769)	(3.526)	(2.716)	(2.335)

Figures in parenthesis are angular transformed values; HAT- Hours after treatment*Mean of 3 replications, No of insects/ replication-20

III population. The resistance ratio was calculated by taking Location I population as base and the values were 1.85 and 1.28 for Location II and Location III populations respectively. While LC_{90} values based on resistance ratio were observed as 1.40 and 1.11 for population from Location II and Location III respectively. Based on the LC_{50} and LC_{90}values whiteflies collected from Location II were the resistant population. The results showing the toxicity towards the imidacloprid is shown in the table 3.

The results of the current study publicised that population collected from location-I was observed to be susceptible to insecticides *viz*., fenvalerate followed by imidacloprid and quinalphos which was considered as reference strain. Population collected from location-II showed comparatively higher resistance with resistance ratio of 2.60, 2.90 and 1.85 and population from location-III was found to be moderately resistant with resistant ratio of 1.14, 1.62 and 1.28 against quinalphos, fenvalerate and imidacloprid respectively. Considering the resistance shown by whitefly population towards quinalphos and imidacloprid in location II, quinalphos showed higher resistance (2.6- folds) than imidacloprid (1.85- folds). However, in location III a greater resistance of 1.28 was shown by whitefly population against imidacloprid than quinalphos (1.14- folds). This shows the higher use of organophosphates in location II compared to location III.

High resistance to organophosphates, carbamates, pyrethroides, chlorinated hydrocarbons and insect growth regulators are shown by them in many agriculture systems world-wide (Elbert and Nauen, 2000). Resistance build up against synthetic pyrethroids are much easier when compared to organophosphates and carbamates as they constitute as a singleisomer, which may force the production of detoxifying enzyme resulting in rapid resistance development. However, in case of organophosphates and carbamates they do not exist as a stereo isomer so the insects has to develop

Table 5. Mean number of populations of *A. dispersus* treated with new generation insecticides under field conditions

Treatment	Mean number of whitefly adults per plant after spraying (DAS)*								
	Pre count	0.08	1	2	3	4	5	6	7
Thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC @ 33+15.75 g a.i ha^{-1}	24.60	5.20^{c} (2.24)	0.00^{d} (0.70)	0.00^{d} (0.70)	0.00^{c} (0.70)	0.00^{b} (0.70)	0.00^{b} (0.70)	0.00^{b} (0.70)	0.00^{b} (0.70)
Clothianidin 50% WDG @ 20 g a.i ha^{-1}	23.61	12.60^{b} (3.54)	9.20^{c} (3.11)	5.00^{c} (2.29)	0.00^{c} (0.70)	0.00^{b} (0.70)	0.00^{b} (0.70)	0.00^{b} (0.70)	0.00^{b} (0.70)
Flonicamid 50% WG @ 75 g a.i ha^{-1}	24.40	13.80^{b} (3.72)	11.80^{b} (3.50)	9.40^{b} (3.13)	1.40^{b} (1.28)	0.00^{b} (0.70)	0.00^{b} (0.70)	0.00^{b} (0.70)	0.00^{b} (0.70)
Untreated Control	24.00	21.80^{a} (4.66)	21.80^{a} (4.73)	22.20^{a} (4.78)	22.60^{a} (4.80)	22.80^{a} (4.82)	23.00^{a} (4.84)	23.00^{a} (4.84)	23.00^{a} (4.84)
CD (0.05)	NS	(0.326)	(0.175)	(0.421)	(0.373)	(0.055)	(0.052)	(0.052)	(0.095)

Figures in parenthesis are square root transformed values; DAS- Days after spraying *Mean of 5 replications

several mechanisms, which need many enzyme systems for detoxifying the insecticides (Sreelekshmi, 2014). In 2018, Hampaiah studied the development of resistance in cowpea aphid *Aphis craccivora* and he reported 1.67 – 1.71 fold resistance to quinalphos, 2.97-19.46 fold resistance against fenvalerate and 2.81-7.94 times resistance against imidacloprid. However, reports on insecticide resistance against spiralling whitefly in India is meagre and no studies have been carried out in Kerala.

Evaluation of efficacy of new generation insecticides against the population of *A. disperses* under laboratory condition.

Percentage mortality of relatively resistant population against the new generation insecticides are given in the Table 4. Thiamethoxam12.6% + lambdahcyhalothrin 9.5% ZC @ 33+15.75 g a.i ha^{-1} recorded the highest mortality of 45 per cent after 0.25 hours of treatment which was found to be significantly different from all other treatments, followed by clothianidin50%,WDG @ 20 g a.iha^{-1} with a mortality percentage of 26.67. Flonicamid 50%WG @ 50 g a.i ha^{-1}, cynantraniliprole 10.26% OD @ 90 g a.i ha^{-1} andbuprofezin25%SC @ 75 ga.i ha^{-1} with mortality percentages of 6.67, 3.33 and 1.67 respectively and found to be on par with each other while flonicamid50% WG @ 50 g a.i ha^{-1} (6.67) was found to be significantly different from dinotefuran 20% SG @ 25 g a.i ha^{-1} and thiamethoxam 25% WG @ 50 g a.i ha^{-1} with no mortality. After 0.5 hours of treatment, thiamethoxam 12.6%+lambda cyhalothrin 9.5%ZC @ 33+15.75 ga.iha^{-1} showed a mortality of 66.67per centwhich was on par withclothianidin50% WDG@ 20 g a.iha^{-1} (65%) which were significantly different from others. Mortality percentage of 36.67 was observed in case of flonicamid50%,WG @ 50 g a.iha^{-1} which was on par with cynantraniliprole 10.26% OD @ 90g a.i ha^{-1} (35%). Dinotefuran20%SG @ 25 g a.i ha^{-1} recorded 16.67 per cent mortality which was significantly different from buprofezin25% SC@ 75g a.i ha^{-1} (5%) and thiamethoxam25% WG @ 50 g a.i ha^{-1} (1.67%), which were on par. The control treatment recorded no mortality which was on par with thiamethoxam 25% WG @50 g a.iha^{-1} (1.67%).

Thiamethoxam12.6%+ lambdacyhalothrin 9.5%ZC @33 + 15.75 g a.i ha^{-1} recorded cent percent mortality after 0.75 hours of treatment followed by clothianidin50%WDG @ 20 g a.iha^{-1} (80%) and flonicamid50% WG @ 50 g a.i ha^{-1} (66.67%). Cynantraniliprole 10.26% OD @ 90 g a.i ha^{-1} and thiamethoxam 25%WG @ 50 g a.i ha^{-1} had similar mortality percentage of 41.67 which were on par with dinotefuran 20% SG @ 25 g a.i ha^{-1} (35%). Buprofezin25% SC@ 75 ga.i ha^{-1} recorded the lowest mortality (25%) which was significantly different from other treatments and superior to control. After one hour of treatment both thiamethoxam12.6% +lambda cyhalothrin9.5% ZC @ 33+15.75ga.iha^{-1} and clothianidin50% WDG@ 20 g a.iha^{-1} recorded cent per cent mortality followed by flonicamid 50% WG @ 50 g a.i ha^{-1}(78.33%), dinotefuran 20% SG @ 25 g a.i ha^{-1} (68.33%), cynantraniliprole 10.26% OD @ 90 g a.i ha^{-1} (61.67%), thiamethoxam 25% WG @ 50 g a.i ha^{-1}(45%) and buprofezin 25% SC @ 75 g a.i ha^{-1}(28.33%).

Thiamethoxam12.6%+ lambdacyhalothrin 9.5% ZC @ 33+15.75 g a.i ha^{-1}, clothianidin50%WDG @ 20g a.i ha^{-1}, flonicamid50%WG @ 50 g a.i ha^{-1}, dinotefuran20% SG @ 25g a.i ha^{-1} and cynantraniliprole10.26%OD @ 90 g a.i ha^{-1} recorded hundred percent mortality after 1.25 hours of treatment followed by thiamethoxam25%WG @ 50 ga.i ha^{-1} (75%) and buprofezin25% SC @ 75 g a.i ha^{-1} (33.33%). After 1.5 hours all the treatments showed cent per cent mortality except buprofezin25% SC@ 75g a.i ha^{-1}, which recorded only 58.33 per cent. All treatments were superior to the control which recorded no mortality. After 1.75 hour all treatments showed cent percent mortality whereas control recorded no mortality.

Field evaluation of selected new generation insecticides against the population of whiteflies.

The results on the field evaluation of selected new generation insecticides against the relatively resistant population of *A. dispersus* are presented in the Table 5 and the three effective insecticides were thiamethoxam 12.6%+ lambdacyhalothrin 9.5% ZC @ 33+15.75 g a.i ha^{-1}, clothianidin50% WDG @ 20 g a.i ha^{-1} and flonicamid 50% WG @ 75 g a.i ha^{-1}No significant difference was observed in the spiralling whitefly population before spraying among the treatments.

After 0.08 days after treatment thiamethoxam 12.6%+lambda cyhalothrin 9.5% ZC @33+15.75 g a.i ha^{-1} recorded the lowest number (5.20) of adults of spiralling whitefly and was significantly different from other treatments. Clothianidin50% WDG @ 20g a.i ha^{-1} and flonicamid 50% WG @ 50g a.i ha^{-1} recorded 12.60 and 13.80 adult whiteflies per plant respectively and was statistically on par. The highest number of whiteflies was seen in control (21.80).

No whitefly were observed in treatment with thiamethoxam 12.6%+ lambda cyhalothrin9.5% ZC @33+15.75 g a.i ha^{-1} after one day of spraying. While clothianidin 50%WDG @ 20 g a.i ha^{-1} recorded 9.20 and flonicamid50% WG @ 50 g a.i ha^{-1} 11.80 whitefly adults per plant which was significantly different from the control treatment. Similar trend was seen in the second day where thiamethoxam 12.6%+ lambda cyhalothrin9.5% ZC @ 33+15.75 g a.i ha^{-1} recorded no population and clothianidin 50% WDG @ 20 g a.i ha^{-1} (5.00) and flonicamid 50% WG @ 50 g a.i ha^{-1} showed lesser number of adult whiteflies (9.40) than the control (22.20).

Thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC @ 33+15.75 g a.i ha^{-1} and clothianidin 50% WDG @ 20 g a.i ha^{-1} recorded no population at third day of spraying, while flonicamid 50% WG @ 50 g a.i ha^{-1} treated plants recorded 1.40 whiteflies per plant. No whitefly population was observed after third day in all three treatments except control and it retained up to 7 days after spraying and all treatments were found to be non- significant.

The three insecticides found efficient in managing whitefly population belong to neonicotinoid group (thiamethoxam and clothianidin), synthetic pyrethroid (lambda cyhalothrin) and flonicamid. The results from the presentstudy shows the effect of insecticide mixtures inthe management of resistant population. Insecticide resistance can be successfully suppressed if the insecticide mixtures are used which includes different chemicals with different mode of action (Georghiou *et al.*, 1983). In thiamethoxam + lambda cyhalothrin, thiamethoxam belongs to neonicotinoids with mode of action as nicotinic acetyl choline receptor (nAChR) competitive modulators and lambda cyhalothrin is a synthetic pyrethroid with sodium channel blocking activity (IRAC, 2019). Use of insecticide mixtures for resistance management can be substantiated by the combination of insecticides with different mode of action. This results in the synergism where one insecticides enhances the action of other, which can be seen in case of synthetic pyrethroids and organophosphates where organophosphate binds to active site on esterase enzymes which detoxifies pyrethroid enzymes (Ahmad, 2004). The efficacy of thiamethoxam and lambda cyhalothrin was observed to be most effective in managing various pest in different crops *viz.*, tea (Samanta *et al*., 2017), cotton (Borude *et al*., 2018) and cowpea (Hampaiah, 2018).

A prevalent resistance management plan is the need of the hour for the successful management of whiteflies. Several research works have been carried out across the world on the insecticide resistance against *B. tabaci* (Cahill *et al*., 1995). However no study on the insecticide resistance in spiralling whitefly *A. dispersus* has been carried out even though they are causing severe damage in many crops especially vegetables. Compared to old generation insecticides, new generation insecticides have high potential for managing insects ash they are more selective with toxicity to target pests even at lower dose and often not as persistent as conventional insecticides. The present study is a maiden attempt in assessing the development of insecticide resistance in the field populations of *A. dispersus* in tomato in Kerala.

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