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EVALUATION OF SPIROTETRAMAT AND ITS READY MIX FORMULATION WITH IMIDACLOPRID AGAINST TOBACCO APHID, *MYZUS NICOTIANAE* IN TOBACCO

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Tobacco aphid, *Myzus nicotianae* (Blackman) is one of the important insect pests of tobacco in India. Studies were conducted on the efficacy of spirotetramat and its combination with imidacloprid in Flue Cured Virginia (FCV) tobacco (*Nicotiana tabacum*) cv. *Siri* at ICAR-Central Tobacco Research Institute farm, Rajahmundry, India. Results showed that lowest mean aphid population/plant was recorded in the treatment of spirotetramat+ imidacloprid 240 SC @ 0.036% followed by its lower dose (0.018 %) and imidacloprid 200 SL @ 0.005%. Spirotetramat 150 OD alone did not give satisfactory control of the aphid at any of the doses tested though it was found to be significantly better than the un treated control in terms of reduction in aphid population. The highest cured leaf, bright leaf yield and grade index were recorded in the spirotetramat + Imidacloprid 240 SC @ 0.036% followed by spirotetramat + Imidacloprid 240 SC 0.018 % and imidacloprid 200 SL @ 0.005%. Studies on persistent residual toxicity to the aphid on tobacco showed that the period of persistency was 24 days for spirotetramat + Imidacloprid 240 SC @ 0.036%, 0.018 % and imidacloprid 200 SL @ 0.005% with a persistent toxicity index of 1975, 1949 and 1916, respectively.

INTRODUCTION

Tobacco aphid, *Myzus nicotianae* (Blackman) is an important sucking pest of Virginia tobacco in India. The nymphs and adults suck the sap from tobacco leaves and cause significant loss. They secrete honey dew which favours the development of sooty mold on the leaves resulting in inferior quality tobacco. Also they cause indirect loss as vectors of viral diseases particularly the cucumber mosaic virus. High infestation (80 - 100%) has been reported in unprotected fields in the years of severe incidence (Sreedhar *et al.*, 1993). In Virginia tobacco, it was estimated that the aphid caused an avoidable loss of green leaf, cured leaf and bright leaf to an extent of 607 kg,125 kg and 70.3 kg/ha, respectively (CTRI,1993). The registered insecticides that provide adequate control of the pest continued to decrease either due to ban or withdrawal of certain insecticides on tobacco in view of the residue problem due to lowered guidance residue levels. As the pest appears late in the season repeated application of certain insecticides to control the pest may lead to the buildup of residues. Tobacco leaves with large surface to weight ratio are vulnerable to retain the pesticide residues, which is not desirable. At present only two insecticides *viz.*, imidacloprid and thiamethoxam are available which are being used for more than two decades by the farmers (Rama Prasad *et al.*, 1998; Sreedhar and Krishnamurthy, 2007). Studies have indicated the possibility of developing resistance in aphid species to these insecticides (Harlow and Lampert, 1990; Srigiriraju *et al.*, 2010). Also, Neonicotinoid use has been linked in a range of studies to adverse ecological effects, including honey-bee colony collapse disorder (CCD) and loss of birds due to a reduction in insect populations. Recent studies by the European Food Safety Authority (EFSA) have confirmed the risk to bees due to the neonicotinoids (EFSA, 2018). 12 neonicotinoids are under consideration for ban by The Environmental Protection Agency. Hence, there is an urgent need to evaluate new mode of action insecticides for effective management of aphids. Spiroteramat belongs to the ketoenols group with unique translocation properties within the entire vascular system (both xylem and phloem). In view of the problems associated with sole dependence on imidacloprid and thiamethoxam for management of aphids, it is imperative to evaluate new

Key Words: Tobacco, *Nicotiana tabacum*, tobacco aphid, *Myzus nicotianae*, insecticides, spirotetramat, insecticide mixture

molecules with different mode of action in Virginia tobacco.

MATERIALS AND METHODS

A replicated field experiment was conducted for two seasons in planted flue cured Virginia tobacco cv. Siri at the institute during 2011-13 to evaluate the efficacy of spirotetramat 150 OD @ 0.006%, 0.012%, 0.024%, spirotetramat+ imidacloprid 240 SC @ 0.009%, 0.018% & 0.036% in comparison with imidacloprid 200SL @0.005% against tobacco aphid, *M.nicotianae* on FCV tobacco. The experiment was laid out in randomized block design with three replications in plots measuring 5.6 X 4.9 m with a row to row and plant to plant distance of 70 cm. The treatments were imposed using the knapsack sprayer fitted with hollow cone nozzle. To maintain optimum level of aphid infestation, five plants/plot were infested with 100 aphids on each plant coinciding with the appearance of aphids naturally in the field. Observations on the aphid population were made on five plants from each plot following the method of Sreedhar *et al.* (1993). The indices 0- 5 were standardized by counting the number of aphids on 3 (top, middle, bottom) leaves/plant which formed a particular index (0-5). At the time of recording observations, the aphids based on the numbers will fall in one of these indices and these indices were converted to their corresponding numbers. The average number of aphids on a plant was determined by adding up the aphids on three leaves per plant and average numbers recorded on 5 plants were considered as number of aphids/ plant. Observations on aphid population were recorded before spraying as well as 2, 4, 8 and 16 days after spray (DAS). Yield data on cured leaf, bright leaf and grade index were collected. The data on aphid population in different treatments and the yield data were subjected to statistical analysis of variance (ANOVA) as per Gomez and Gomez,1984. The persistent residual toxicity of spirotetramat 150 OD @ 0.024%, spirotetramat+ imidacloprid 240 SC @ 0.018% & 0.036% and imidacloprid 200SL 0.005% was studied. Fifty day old tobacco plants were treated with respective insecticides and the leaves were used to study the residual persistent toxicity from 0 days till there is no mortality in that particular treatment at 24 hrs interval. One hundred second instar aphids were released on each treated leaf and mortality was recorded at 24 hrs interval till the mortality dropped to zero. The persistent residual toxicity was determined by slightly modifying the method suggested by Pradhan (1967) and as used by Sarup *et al.* (1970) subsequently.

RESULTS AND DISCUSSION

All the treatments were superior to control during both the seasons as shown by significantly less aphid population at 2, 4, 8 and 16 DAS (Table 1). During 2011-12 the mean aphid population at 2 DAS was recorded the least (3.35/plant) in spirotetramat + imidacloprid @ 0.036% and it remained on par (3.58) with its lower dose 0.018% and imidacloprid (3.81). Aphid population (5.90) in spirotetramat+ imidacloprid @ 0.09% was found to be on par (7.11) with the highest dose (0.024%) of spirotetramat. At 4 DAS spirotetramat+ imidacloprid @ 0.018& 0.036 % and imidacloprid 0.005 % recorded cent per cent mortality. The treatment of spirotetramat+ imidacloprid @ 0.009 % recorded 4.18 aphids /plant which was significantly less as compared to all the doses of spiroteramet. The population in spirotetramat @ 0.012% (7.11) and 0.024 % (5.90) was on par with each other and significantly less than that in the control plots. Similar trend was observed at 8 and 15 days after spray. During 2012-13 more or less similar trend was observed. At 2 DAS, where aphid population was observed to be the least (3.29/ plant) in spirotetramat + imidacloprid @ 0.036% and it remained on par (4.01) with its lower dose 0.018% and imidacloprid (3.58). Aphid population (6.36) in spirotetramat+ imidacloprid @ 0.009% was found to be on par (7.57) with the highest dose (0.024%) of spirotetramat. At 4 DAS, spirotetramat + imidacloprid @ 0.018 & 0.036 and imidacloprid 0.005 recorded cent per cent mortality. The treatment of spirotetramat + imidacloprid @ 0.009 % recorded 6.04 aphids / plant which was on par with medium and higher doses of spiroteramat. The results clearly indicated the effectiveness of spirotetramat + imidacloprid 240 SC @ 0.018% & 0.036% against tobacco aphid, *M.nicotianae* during both the seasons. The findings of the current study are in conformity with earlier reports on effectiveness of the spirotetramat+ imidacloprid mixture against sucking pests on various crops (Sinha and Sharma 2014; Kumar *et*

al., 2015; Sunda *et al.*, 2015; Venkateshalu and Math, 2016; Koushik Sen *et al.*, 2017; Nevgi, 2018) The population in spirotetramat @ 0.012% (7.71) and 0.024 % (6.04) was on par with each other and significantly less than that in the control plots. Identical trend was observed at 8 and 15 days after spray. It is evident from the data that spirotetramat alone was inferior and relatively ineffective compared to the mixture and imidacloprid. The inferiority of spirotetramat 150 OD alone against sucking pests in different crops was reported earlier (Verghese and Mathew, 2012; Koushik Sen *et al.*, 2017).

TOBACCO YIELD

All the treatments recorded higher cured leaf and bright leaf yields and recorded better grade index compared to control plots during both the seasons (Table 2). Pooled data of two seasons showed that the treatment of spirotetramat + imidacloprid @ 0.036% recorded the highest cured leaf yield (2017 kg/ha) followed by spirotetramat + imidacloprid @ 0.018% (2012 kg/ha) and imidacloprid @ 0.005% (1985 kg/ha) which were on a par with one another. Among the treatments spirotetramat alone at all the doses was inferior to the combination of spirotetramat + imidacloprid and imidacloprid alone and recorded lower cured leaf yield though the yields were significantly higher than untreated control. As regards bright leaf, all the treatments yielded higher bright leaf yield than control (640 kg/ha). The highest bright leaf yield (1101 kg/ha) was obtained in spirotetramat + imidacloprid @ 0.036% followed by spirotetramat + imidacloprid @ 0.018% (1097 kg/ha) and imidacloprid @ 0.005% (1017 kg/ha). Significantly higher grade index was recorded in all the treatments compared to control during both the seasons. The highest grade index (1693) was recorded in spirotetramat + imidacloprid @ 0.036% treatment followed by spirotetramat + imidacloprid @ 0.018% (1676) and imidacloprid @ 0.005% (1585) which were on a par with each other. Higher yield parameters of Virginia tobacco clearly indicated the superiority of spirotetramat + imidacloprid @ 0.036% & 0.018% and imidacloprid @ 0.005% in controlling the aphid resulting in higher cured leaf, bright leaf and better grade index during both the seasons.

PERSISTENT RESIDUAL TOXICITY

The data presented (Table 3) show that among the test insecticides, spirotetramat + imidacloprid 240 SC @ 0.036% & 0.018% and imidacloprid @ 0.005% were most persistent insecticides which gave cent per cent mortality of *aphid* till 14 days after spray (DAS). spirotetramat 150 OD @ 0.024% recorded cent per cent mortality up to 4 days only. More than 90 per cent mortality was recorded in spirotetramat + imidacloprid @ 0.036% & 0.018% up to 16 DAS and it was 88.6 in imidacloprid @ 0.005%. The period of persistency was longest (24 days) in case of spirotetramat + imidacloprid @ 0.036% & 0.018% and imidacloprid @ 0.005% where as it was 14 days for the highest dose of spirotetramat 150 OD @ 0.024%. The mean persistent toxicity was highest (82.29) in spirotetramat + imidacloprid @ 0.036% closely followed by spirotetramat + imidacloprid @ 0.018% (81.21) and imidacloprid @ 0.005% (79.84). Similarly the persistent toxicity index was also highest (1975) in spirotetramat + imidacloprid @ 0.036% followed by spirotetramat + imidacloprid @ 0.018% (1949) and imidacloprid @ 0.005 (1916.2). The persistent toxicity index (PTI) was least 1019.2 for spirotetramat 150 OD @ 0.024%. The reduction in effectiveness started from 16 DAS in spirotetramat + imidacloprid @ 0.036%, 0.018%, imidacloprid @ 0.005% and 8 DAS in spirotetramat 150 OD @ 0.024%. Based on the results the order of persistency was found to be spirotetramat + imidacloprid 240 SC @ 0.036% > spirotetramat + imidacloprid 240 SC @ 0.018 > imidacloprid 200 SL @ 0.005 > spirotetramat 150 OD @ 0.024%.

Based on the bio- efficacy data for two seasons, yield data and studies on persistent residual toxicity, it is evident that spirotetramat + imidacloprid 240 SC @ 0.018% effectively protected FCV tobacco from aphid infestation. Hence, it is concluded that spirotetramat + imidacloprid 240 SC @ 0.018% can be used for management of tobacco aphid, *M.nicotianae* in FCV tobacco.

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Table 1: Field efficacy of spirotetramat against tobacco aphid, *Myzus nicotianae*

	Mean aphids /plant									
	Pre- spray		2 DAS		4 DAS		8 DAS		16 DAS	
Treatment	**2011-12**	**2012-13**	**2011-12**	**2012-13**	**2011-12**	**2012-13**	**2011-12**	**2012-13**	**2011-12**	**2012-13**
Spirotetramat 150 OD 0.006%	1044.83	1280.5	21.91 (481.5)	22.28 (495.56)	21.60 (466.5)	21.26 (451.22)	21.40 (458.17)	21.40 (456.87)	20.71 (428.17)	20.71 (428.08)
Spirotetramat	1051.5	1113.1	8.45	8.85	7.11	7.71	7.11	6.36	7.12	5.59
150 OD 0.012%			(70.67)	(77.26)	(50.60)	(58.43)	(50.60)	(39.50)	(50.60)	(30.21)
Spirotetramat	906.5	1094.8	7.11	7.57	5.90	6.04	5.90	5.59	5.37	3.95
150 OD 0.024%			(50.60)	(56.32)	(34.00)	(35.53)	(34.00)	(30.21)	(28.90)	(14.58)
Spirotetramat +	1018.17	1044.8	5.9	6.36	4.18	6.05	3.06	4.17	2.77	3.06
Imidacloprid			(34.00)	(39.50)	(17.0)	(35.58)	(8.53)	(16.45)	(6.87)	(8.37)
240 SC @ 0.009%										
Spirotetramat +	1094.83	1028.1	3.58	4.01	1.00	1.00	1.0	1.0	1.0	1.0
Imidacloprid			(11.90)	(15.08)	(0.00)	(0.00)	(0.0)	(0.0)	(0.0)	(0.0)
240 SC @ 0.018%										
Spirotetramat +	1113.17	1083.1	3.35	3.29	1.0	1.0	1.0	1.0	1.0	1.0
Imidacloprid			(10.20)	(9.80)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
240 SC @ 0.036%										
Imidacloprid	1018.17	1044.8	3.81	3.58	1.0	1.0	1.0	1.0	1.0	1.0
200 SL @0.005%			(13.60)	(11.79)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Control	984.83	1018.1	36.73	39.40	42.13	44.39	57.69	50.22	63.61	63.61
			(1349.77)	(1551.77)	(1776.50)	(1969.66)	(3334.83)	(2531.50)	(4051.5)	(4051.5)
S.Em ±	80.94	82.5	0.63	0.67	0.57	0.84	0.78	0.88	0.74	0.61
CD (p= 0.05%)	NS	NS	1.91	2.04	1.73	2.56	2.39	2.66	2.24	1.86

Figures in parenthesis are retransformed means **DAS= Days After Spray**

Table 2: Field efficacy of spirotetramat on yield parameters of Virginia tobacco

	Cured leaf			Bright leaf			Grade index		
Treatment	**2011-12**	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**
Spirotetramat 150 OD 0.006%	1729	1736	1732	830	863	846	1320	1366	1343
Spirotetramat 150 OD 0.012%	1735	1760	1747	866	880	873	1364	1400	1382
Spirotetramat 150 OD 0.024%	1747	1794	1770	880	900	890	1400	1446	1423
Spirotetramat + Imidacloprid 240 SC @ 0.009%	1806	1860	1833	900	940	920	1440	1520	1480
Spirotetramat + Imidacloprid 240 SC @ 0.018%	2010	2015	2012	1095	1100	1097	1670	1682	1676
Spirotetramat + Imidacloprid 240 SC @ 0.036%	2015	2020	2017	1100	1102	1101	1690	1696	1693
Imidacloprid 200 SL @ 0.005%	1960	2010	1985	985	1050	1017	1550	1620	1585
Control (Untreated)	1440	1560	1500	620	660	640	970	1010	990
S.Em ±	75	81	55	37	51	64	59	80	49
CD (p= 0.05%)	228	246	160	113	156	186	179	242	144

Table 3: Persistent residual toxicity of spirotetramat against *M.nicotianae*

Treatment	Per cent mortality (Days after treatment)														Period of persistency (P)	Mean persistent toxicity (PT)	Persistent toxicity index (PTI)
	0	2	4	6	8	10	12	14	16	18	20	22	24	26			
Spirotetramat 150 OD 0.024%	100	100	100	100	80.6	58.4	30.8	12.6	0	-	-	-	-	-	14	72.8	1019.2
Spirotetramat + Imidacloprid 240 SC @ 0.018%	100	100	100	100	100	100	100	100	90.6	76.8	50.2	30.0	8.2	0	24	81.21	1949.0
Spirotetramat + Imidacloprid 240 SC @ 0.036%	100	100	100	100	100	100	100	100	92.8	78.2	54.6	32.2	12.0	0	24	82.29	1975.0
Imidacloprid 200 SL @ 0.005%	100	100	100	100	100	100	100	100	88.6	68.8	48.0	26.2	6.4	0	24	79.84	1916.2

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