Evaluation of new insecticides for the management of tobacco aphid, *Myzus nicotianae* in virginia tobacco

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Abstract

Tobacco aphid, Myzus nicotianae, *is an important pest of tobacco in India. A replicated field experiment was conducted for two seasons during 2012-13 and 2013-14 in flue cured Virginia (FCV) tobacco (*Nicotiana tabacum*) cv.* Siri *to evaluate certain new insecticides for the management of aphid and its effect on associated natural enemies. Flonicamid 50 WG and pymetrozine WG @ 0.02% provided cent per cent control up to 16 days after treatment. Both the insecticides were found to be relatively safe to the tobacco aphid predators,* Cheilomenes sexmaculata *and* Xanthogramma scutellarae. *The new insecticides recorded higher cured leaf, bright leaf and better grade index than others. Studies on persistent residual toxicity on tobacco showed highest persistent toxicity index of 2092.2 for flonicamid and 1951.2 for pymetrozine.*

Keywords: Tobacco, *Myzus nicotianae*, flonicamid, pymetrozine, *Cheilomenes sexmaculata*, *Xanthogramma scutellarae*

Introduction

Tobacco aphid, *Myzus nicotianae* Blackman is one of the important pests of Virginia tobacco in India. Its high infestation (80-100%) has been reported in unprotected fields in the years of severe incidence (Sreedhar *et al.*, 1993). The nymphs and adults of the aphid 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. 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). Hence, new modes of action insecticides are required for effective management of aphids. Flonicamid, a pyridinecarboxamide compound with systemic as well as translaminar activity, rapidly inhibits the feeding behaviour of aphids, it is having a different mode of action to that of neo-nicotinoids and is reported to be relatively safe to the natural enemies. Pymetrozine, a pyridine azomethine compound, blocks stylet penetration of aphids causing immediate cessation of feeding. It is having high degree of selectivity, low mammalian toxicity, safe to birds, fish, and nontarget arthropods. Spiromesifen, a tetronic acid derivative belonging to the chemical class of ketoenols is a lipid biosynthesis inhibitor, prevents insects from maintaining required water balance that results in mortality of the sucking insects and is safe to bees. Spiroteramat belongs to the same 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 in tobacco, it is imperative to evaluate new chemistry molecules effective at low dose of active ingredient, with different mode of action and their safety to the native natural enemies in Virginia tobacco.

Materials and methods

A replicated field experiment was conducted for two seasons in planted flue cured Virginia tobacco cv. *Siri* at Central Tobacco Research Institute, Rajahmundry during 2012-14 to evaluate the efficacy of pymetrozine 50 WG @ 0.02%, flonicamid 50 WG @ 0.02%, spiromesifen 240 SC @ 0.02%, and spirotetramat + imidacloprid 240 SC @ 0.018% in comparison with imidacloprid 17.8 SL @ 0.005% and thiamethoxam 25 WG @ 0.005% for management of tobacco aphid. The experiment was laid out in randomized block design with 3 replications in plots measuring 5.6 × 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, 5 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 5 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). The data were recorded on 0-5 scale based on the numbers of aphids that 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). Observations on predator population were recorded on 5 randomly selected plants per plot on whole plant basis. The data on population count were used to work out per cent reduction in population over untreated control by using the following formula and the data were subjected to statistical analysis of variance (ANOVA).

$$\text{Per cent reduction of predators} = \frac{\text{Population in untreated control plot} - \text{Population in treatment}}{\text{Population in control}} \times 100$$

Yield data on cured leaf, bright leaf and grade index were recorded and subjected to ANOVA (Gomez and Gomez, 1984). The persistent residual toxicity of pymetrozine 50 WG 0.02%, flonicamid 50 WG 0.02%, spirotetramat + imidacloprid 240 SC 0.018%, imidacloprid 200 SL 0.005%, thiamethoxam 25 WG 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 h interval. One hundred second instar aphids were released on each treated leaf and mortality was recorded at 24 h 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

Efficacy against tobacco aphid

The pooled data on pre-spray population of tobacco aphid varied from 1011.5 to 1069.8 (Table 1) in various treatments and the data did not differ significantly. After two days of spray (DAS) the mean aphid population was least (7.5) in flonicamid 50 WG @ 0.02% closely followed by pymetrozine 50 WG @ 0.02% (9.9). Except in spiromesifen, aphid population in all the treatments was on par with each other. Spiromesifen 240 SC @ 0.02% recorded highest aphid population (43.2) but it was significantly less than that of control (1193.9). At 4 DAS, all the treatments recorded cent per cent control except spiromesifen treatment in which there was a reduction (33.9) in population as compared to 2 DAS. Similar trend was observed up to 16 DAS. Cent per cent control of tobacco aphid was recorded in all the treatments except spiromesifen, which recorded significantly less population compared to that in control. The aphid population increased progressively in control treatment and reached a peak of 3771.9 at 16 DAS during the two seasons. Flonicamid, a pyridinecarboxamide compound, is a novel systemic insecticide with selective activity is highly effective against aphids, regardless of differences in species, stages and morphs (Morita *et al.*, 2007). Effectiveness of flonicamid against aphids was also reported on various crops (Ghelani *et al.*, 2014; Boquel *et al.*, 2015; Gaurkhede *et al.*, 2015). Pymetrozine, a pyridine azomethine compound, is a novel insecticide with selective action against homopteran insects. Effectiveness of pymetrozine against aphids on tobacco and other crops has been reported (Foster *et al.*, 2002; Margaritopoulos *et al.*, 2010). Inferior effectiveness of spiromesifen compared to imidacloprid and thiamethoxam was reported against aphids, (Rawat *et al.*, 2013; Patil 2015). Thus, the effectiveness of different insecticides against tobacco aphid observed in the present study is in conformity with the previous research findings.

Effect on predators

The data in Table 1 showed that pymetrozine 50 WG and

Table 1. Field efficacy of new insecticides against tobacco aphid, *Myzus nicotianae* and its natural enemies (Pooled data of 2012-13 and 2013-14)

Treatments	Mean aphid population/plant					Per cent reduction of predators over control	
	Pre - spray	2 DAS	4 DAS	8 DAS	16 DAS	*C. sexmaculata*	*X. scutellarae*
Pymetrozine 50 WG 0.02%	1067.3	9.9 (3.3)	0.0 (1.0)	0.0 (1.0)	0.0 (1.0)	37.1 (36.0)	29.3 (24.0)
Flonicamid 50 WG 0.02%	1053.2	7.5 (2.9)	0.0 (1.0)	0.0 (1.0)	0.0 (1.0)	41.8 (44.1)	32.8 (28.5)
Spirotetramat + imidacloprid 240 SC 0.018%	1011.5	11.8 (3.6)	0.0 (1.0)	0.0 (1.0)	0.0 (1.0)	62.6 (78.8)	66.2 (81.0)
Imidacloprid 17.8 SL 0.005%	1069.8	13.5 (3.8)	0.0 (1.0)	0.0 (1.0)	0.0 (1.0)	66.2 (81.0)	64.8 (80.1)
Thiamethoxam 25 WG 0.005%	1052.3	13.5 (3.8)	0.0 (1.0)	0.0 (1.0)	0.0 (1.0)	54.2 (66.2)	54.8 (66.8)
Spiromesifen 240 SC @ 0.02%	1025.0	43.2 (6.6)	33.9 (5.9)	30.2 (5.6)	37.9 (6.2)	36.4 (34.9)	30.6 (26.0)
Control	1020.7	1193.9 (34.6)	1482.8 (38.5)	2515.6 (50.2)	3771.9 (61.4)	-	-
SEm ±	53.8	0.4	0.34	0.47	0.52	1.9	1.4
CD (P= 0.05)	NS	1.11	0.99	1.36	1.51	5.4	4.0

Figures in parentheses are retransformed means DAS = Days after spray

flonicamid WG @ 0.02% were relatively safe as compared to imidacloprid, thiamethoxam and spirotetramet + imidacloprid to both the predators *viz., C. sexmaculata* and *X. scutellarae* during both the seasons. Among promising treatments against the pest, the reduction in population of *C. sexmaculata* was highest (66.2%) in imidacloprid followed by, spirotetramat + imidacloprid (62.6%) and thiamethoxam (54.2%), which was significantly high compared to pymetrozine (37.1%) and flonicamid (41.8%) during the two seasons. However, the reduction was least (36.4%) in spiromesifen, which was also inferior in controlling the tobacco aphid. Regarding *X. scutellarae,* highest reduction of 66.2 per cent was recorded in spirotetramat + imidacloprid followed by imidacloprid (64.8%). The least reduction was observed in pymetrozine treatment (29.3%). These results indicate that among the effective insecticides against tobacco aphid, pymetrozine and flonicamid are relatively safe to the predators in the tobacco crop ecosystem. The relative safety of pymetrozine and flonicamid was also reported against various natural enemies (Reber and Bourgeois, 2002; Cabral *et al.*, 2008; Jansen *et al.*, 2011; Chandi *et al.*, 2016). The safety of pymetrozine and flonicamid to the predators helps in conservation of native natural enemies in tobacco ecosystem.

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 flonicamid recorded the highest cured leaf yield (2020 kg/ha) followed by pymetrozine (2002 kg/ ha), which were on par with all the treatments during both the seasons except that of spiromesifen. Among treatments, spiromesifen recorded lowest cured leaf yield (1752kg/ ha) during both the seasons though it was significantly higher than that of control (1557 kg/ha). It remained on par with control during 2012-13. As regards bright leaf, all the treatments yielded higher bright leaf yield than control (705 kg/ha). The highest bright leaf yield (1085 kg/ha) was obtained in flonicamid treatment followed by pymetrozine (1042 kg/ha) and all other treatments were at par with these two except spiromesifen (780 kg/ha). Significantly higher grade index was recorded in all the treatments compared to control during both the seasons. The highest grade index was recorded (1660) in flonicamid treated plots followed by pymetrozine (1633), which were on par with other treatments except that of spiromesifen which recorded lowest grade index (1355) among the treatments. Higher yield parameters of Virginia tobacco clearly indicated the

Table 2. Field efficacy of new insecticides on yield parameters of Virginia tobacco

Treatments	Cured leaf (kg/ha)			Bright leaf (kg/ha)			Grade index		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
Pymetrozine 50 WG 0.02%	2025	1980	2002	1098	986	1042	1700	1566	1633
Flonicamid 50 WG 0.02%	2040	2000	2020	1120	1050	1085	1720	1600	1660
Spirotetramat + imidacloprid 240 SC 0.018%	2015	1956	1985	1080	960	1020	1680	1534	1607
Imidacloprid 17.80 SL 0.005%	2010	1950	1980	1066	956	1011	1630	1530	1580
Thiamethoxam 25 WG 0.005%	2000	1938	1969	1062	945	1003	1625	1526	1576
Spiromesifen 240 SC @ 0.02%	1787	1717	1752	740	820	780	1400	1310	1355
Control	1573	1540	1557	700	710	705	1100	1096	1100
SEm ±	77	54	57	41	48	24	84	41	55
CD (P= 0.05)	236	163	166	127	146	71	257	125	162

superiority of onicamid and pymetrozine in controlling the aphid resulting in higher cured leaf, bright leaf and better grade index during both the seasons.

Persistent toxicity studies

Among the promising treatments, superior persistence of pymetrozine 50 WG @ 0.02% and flonicamid 50 WG @ 0.02% is evident as shown by higher PT values (81.30 and 80.47). Flonicamid recorded cent per cent mortality of the aphid up to 16 days after treatment whereas in all others except thiamethoxam cent per cent mortality was recorded up to 14 DAT (Table 3). The period of persistency was longest (26 days) for flonicamid whereas it was same (24 days) for all other treatments. In earlier studies, Sreedhar *et al.* (1999) also reported that imidacloprid and pymetrozine showed 24 days of persistence on tobacco. The persistent toxicity index (PTI) was the highest (2092.22) for flonicamid followed by pymetrozine (1951.20). The order of persistency was flonicamid > pymetrozine > sprotetramat + imidacloprid > imidacloprid > thiamethoxam.

Flonicamid 50 WG and pymetrozine 50 WG @ 0.02% not only provided effective control of tobacco aphid, *M. nicotianae,* but also were found to be relatively safe to the predators in tobacco ecosystem compared to other insecticides. Based on their effectiveness and persistent residual toxicity against the aphid, safety in terms of selectivity to the aphid predators, *C. sexmaculata* and *X. scutellarae*, flonicamid and pymetrozine can be ideal components of IPM against the tobacco aphid in flue cured Virginia tobacco.

Table 3. Persistent residual toxicity of new insecticides against *M. nicotianae*

Treatment	Per cent mortality at 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			
Pymetrozine 50 WG 0.02%	100	100	100	100	100	100	100	100	94.2	76.6	50.8	27.4	8.0	0.0	24	81.30	1951.20
Flonicamid 50 WG 0.02%	100	100	100	100	100	100	100	100	100	90.8	74.6	40.2	16.8	4.2	26	80.47	2092.22
Spirotetramat + Imidacloprid 240 SC 0.018%	100	100	100	100	100	100	100	100	92.8	78.0	50.0	28.2	6.6	0.0	24	81.20	1948.80
Imidacloprid 17.8 SL 0.005%	100	100	100	100	100	100	100	100	89.2	70.2	48.4	26.0	6.2	0.0	24	78.40	1920.00
Thiamethoxam 25 WG 0.005%	100	100	100	100	100	100	100	96.2	80.6	58.8	40.6	18.4	4.6	0.0	24	76.86	1844.64

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