2004 BELTWIDE COTTON CONFERENCES, SAN ANTONIO, TX – JANUARY 5-9

FIELD PERFORMANCE OF FLONICAMID (F1785) IN COTTON

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Abstract

Flonicamid (F1785), a new pyridinecarboxamide insecticide, is under evaluation for control of sucking pests in a diverse array of crops. It is novel chemistry with a mode of action unlike that for any currently known insecticide; therefore, cross-resistance is unlikely to occur. In 2003, the third year of North American field development efficacy trials, the results continued to indicate excellent aphid control in virtually all crops tested. In cotton, flonicamid exhibits excellent initial and extended residual activity on cotton aphid (*Aphis gossypii* Glover). This activity is generally superior to the older aphicides and equivalent to or better than the neonicotinoids. Against plant bugs (*Lygus lineolaris* Palisot de Beavois and *L. hesperus* Knight), flonicamid appears to exhibit greater activity on nymphs as compared to adults. The observed level of activity, against both nymphs and adults, is comparable to existing and newer plant bug insecticides. Safety to beneficial insects has been demonstrated for a large number of species found in cotton. Flonicamid is an excellent candidate for use in integrated pest management strategies in cotton.

Introduction

Flonicamid (F1785, IKI220) is among the newest insecticides currently under development by FMC. Flonicamid, a pyridinecarboxamide, is highly specific for sucking pests with a novel mode of action. Distinct from the neonicotinoids (Morita et. al. 2000; Hancock, et. al. 2003), the site of action of flonicamid is unique with no affect on nicotinic acetylcholine esterase. Flonicamid exhibits no activity on target sites associated with the organophosphate or carbamate (acetylcholinesterase) insecticides; nor those associated with formamidines (octopamine or nitrous oxide receptors and nitric oxide synthase). Similarly, other well-known insecticide active sites (mitchondrial respiration, GABA-receptors and Na^{++} channel blockers) demonstrate no affinity for or activity in response to exposure to flonicamid. Research on the specific mode of action continues, yet work to date indicates that flonicamid does not, and likely would not, exhibit cross-resistance to any other currently known insecticide mode of action.

Since acquiring the development and marketing rights to flonicamid in the Americas and other geographies from Ishihara Shangyo Kaisha, Ltd. (ISK) in 2001, FMC has conducted extensive field research to determine its level and extent of insecticide activity among the various pest spectra. Limited research has proceeded in university field trials; however, among those working with this compound, excellent activity has been demonstrated among a wide spectrum of economic aphid pests in numerous crops. Among other Hemiptera, fair to good activity has been observed among plant bugs and various fleahoppers.

Cotton has been a focus of research with flonicamid. Targeted principally on cotton aphid (*Aphis gossypii* Glover), results supporting good to excellent control of this pest have been published (Parker and Norman, 2003). Suppression and control of plant bugs (*Lygus lineolaris* Palisot de Beavois and *L. hesperus* Knight) have also been reported (Freeman, 2003; Greene and Caps, 2003; Reed et. al., 2003; Johnson et. al., 2003). Efficacy on cotton fleahopper has been reported as well (Parker and Livingston, 2003). It is the intent of this paper to present an overview of all existing flonicamid cotton data generated from FMC and university cotton field research over the period 2001-2003 and to describe the utility of this novel insecticide in an integrated pest management program.

Materials and Methods

Flonicamid field trials employed B_t and non-B_t varieties of cotton in minimum and conventional tillage systems. All trials utilized fully replicated experimental designs, typically a randomized complete block with a minimum of four replications. Application methods were generally those used in small plot research including CO^2 backpack and self-propelled spray equipment. Both hollow-cone and flat fan type nozzles, usually two per row were reported in use. Application gallonage ranged primarily between 10 to 15 gallons per acre. The majority of programs employed single applications of flonicamid. Plot size varied across trials but usually were 2 to 4 rows x 50 to 100 ft.

Flonicamid (F1785) application rates generally ranged from 0.044 to 0.088 lb ai/a (50 to 100 g ai/ha). Comparative standards employed in all trials were generally of the neonicotinoid class. Additional specific comparative standards and rates were used as needed. Untreated controls were utilized throughout.

Cotton aphid field trials were generally applied at local threshold or later. In some cases, cotton aphid populations were promoted with one or more pyrethroid oversprays. Plant bug trials were conducted in the field using similar experimental designs, plot sizes and application methods.

Quantitative data were collected to assess efficacy in all cases. Sampling techniques varied by researcher. Assessments of insecticide efficacy on aphids were generally based on counts of pests per number of leaves or terminals (ranging from one to 10). Plant bug assessments were based on dislodged pests captured on a beat cloth or by sweeps. These data were expressed as pests per number of row feet (usually 6 to 18 row feet). Evaluations of all target pests began several to 0 days before application to establish initial population levels, with post-treatment evaluations generally occurring at 3 to 4 day intervals through 28 days (in sustained populations) to capture the longevity of flonicamid activity.

Results and Discussion

Flonicamid efficacy trials were conducted exclusively among FMC researchers in 2001, with a limited number of trials initiated late in the season. In the succeeding 2002 and 2003 seasons, a greater number of trials were established with more university participation. In this three-year period, cotton aphid populations were typical (moderate to heavy infestations) during the first two years. In 2003, pest infestations were somewhat lower and more sporadic. Similarly, plant bug populations were variable in several areas during the conduct of this work.

Aphid

In 2001, range finding research indicated a high level of flonicamid activity on cotton aphid (Table 1). In this limited work, flonicamid exhibited little rate related effects with all treatments (0.022 to 0.088 lb ai/a) providing excellent control (>90%) through 7 days after treatment (DAT).

Subsequent research was conducted with a more focused flonicamid rate range (0.036 to 0.088 lb ai/a) and with an array of comparative standards; flonicamid continued to exhibit superlative cotton aphid control in 2002 (Table 2). This work confirmed earlier results and demonstrated comparable or greater activity versus the neonicotinoids (acetamiprid, imidacloprid and thiamethoxam), pyridine azomethine (pymetrozine) carbamate (carbofuran) and organophosphate (dicrotophos) standards though 10 DAT. This research also provided clear evidence of the suspected extended residual efficacy of flonicamid, which generally far exceeded that of the standards (where data were available).

Three series of trials were conducted in 2003; the first two being in-house research projects. In the first series, which used approximately the same range of flonicamid rates as in previous trials, the activity on cotton aphid was again excellent and exhibited similar trends in rate response and longevity of efficacy (Table 3). Performance relative to the standards, which had fewer observations overall, remained comparably high. In the second later season series of trials, using a more restricted flonicamid rate range (0.027 to 0.063 lb ai/a), the current and previous years' trends were further confirmed by excellent activity and exceptional residual efficacy (Table 4). In eight concurrent university field trials, flonicamid exhibited good to excellent control versus an array of comparative chemistry (Table 5). This work further validated in-house efforts, demonstrating comparable or better flonicamid performance, in the hands of other researchers, when compared to a wide range of insecticide modes of action.

An analysis of the 18 field trials conducted in 2003, which focused on the likely field use rate range of flonicamid (0.044 to 0.063 lb ai/a) as well as several of the neonicotinoids which are currently being used or tested against cotton aphid, define flonicamid as a highly effective aphidicide for cotton aphid (Table 6). These results also characterize the long residual efficacy of flonicamid as compared to the neonicotinoids. Extending this analysis across all three years of research (35 trials), provides a robust comparison of neonicotinoids, an OP and a carbamate (Table 7). These results define flonicamid as a highly effective and long-lasting cotton aphicide. The performance of flonicamid is generally superior to that of the compounds representing the three classes of chemistry evaluated in terms of initial and residual performance.

Tarnished Plant Bug

Flonicamid research on plant bug efficacy in cotton has been an additional objective over the 2002-2003 period and has been conducted among in-house, university and contract researchers. Evidence of flonicamid activity on plant bug had previously been observed in cotton aphid trials. Initial results from a few defined trials using the previous flonicamid rate range (0.036 to 0.088 lb ai/a) on a moderate and declining population of tarnished plant bug (TPB), depicted reasonably good activity on combined adults and nymphs through 10DAT (Table 8). After 10 DAT, populations of TPB declined to a point such that comparisons were not valid. However, prior to 10DAT, flonicamid afforded efficacy comparable to the neonicotinoids (acetamiprid, thiamethoxam) and the pyrethroid + neonicotinoid combination (cyfluthrin + imidacloprid). In this work, only the zetacypermethrin (pyrethroid, applied alone) demonstrated greater activity. The same general trends among treatments were observed in square retention as well.

Continued research in 2003, using the same flonicamid rate range and greater pest pressure, provided a contrast to earlier work. The results of three trials tended to indicate greater activity on TPB nymphs versus adults (Table 9). This differential response confirmed earlier field observations not apparent in prior data. In this case, flonicamid activity was less overall versus the neonicotinoid and OP (acephate) standards. However, flonicamid at the high application rate (0.088 lb ai/a) maintained good activity particularly on nymphs through 10DAT.

Western Plant Bug

A similar series of field trials were conducted on Western plant bug (WPB). In the initial studies in 2002, flonicamid (0.036 to 0.088 lb ai/a) also exhibited a differential response; greater activity was observed on nymphs as compared to adults under moderate pest pressure (Table 10). As before, flonicamid activity was comparable to the neonicotinoid and pyrethroid + neonicotinoid combination standards for both nymph and adult WPB. The activity of the pyrethroid standard (zetacypermethrin) was superior, in general, to all treatments for adult WPB control. Flonicamid appeared to maintain relatively better residual control, excluding zetacypermethrin, particularly on nymphs.

The singular trial conducted under low WPB pressure in 2003 confirmed trends of activity observed earlier, that is greater flonicamid efficacy on nymphs versus adults and, generally better initial and residual control of WPB as compared to the neonicotinoid and OP standards (Table 11). The second sequential application of flonicamid treatments clearly performed better than the neonicotinoids on nymphs and appeared to provide a greater overall level of control on adults at 3 DAT following the second application. Again, these results, gathered under low and declining pest pressure, require much further work to confirm these trends.

Conclusions

The results presented here clearly define the excellent activity and residual control provided by flonicamid against the cotton aphid. Use of flonicamid in an integrated cotton pest management program would be advantageous for producers for a number reasons in addition to its high level of aphicidal performance. Paramount among these is the novel mode of action; flonicamid would afford a valued insecticide rotation for resistance management. This attribute will become more critical as compounds with a long history of use become less efficacious and as operational use of multiple neonicotinoids increases. The apparent long residual efficacy of flonicamid on cotton aphid could potentially reduce the number of needed aphicide applications and, perhaps, provide the basis for a prophylactic program when coupled with effective pest scouting. Although work remains to further define activity on plant bugs, results gathered to this point indicate that flonicamid would provide, at a minimum, suppression of plant bugs. Its activity on tarnished and western plant bug nymphs appears to be equivalent or better than many insecticides targeted for this use. Equally important to integrated pest management is the safety of flonicamid on predacious and beneficial insects. Ruberson and Fairbanks (2003) reported the absence of flonicamid effects on *Orius insidiosus* at 4x potential field use rates. Other FMC research (not published) has demonstrated similar safety on the major beneficial and predacious insects of cotton. Recent reports (Sparks and Norman, 2001; Gibson et. al., 2003; Ruberson and Fairbanks, 2003) have clearly defined the adverse effects of older chemistries (OP's, carbamates, pyrethroids) as well as the newer chemistries (neonicotinoid, lactone, oxadiazine) on a variety of predacious and beneficial cotton insects. The combination of excellent cotton aphid efficacy, operational suppression of plant bugs, insecticide rotation and safety to beneficials make flonicamid an ideal tool for integrated pest management

Acknowledgements

The author extends sincere appreciation to the university researchers participating in the Flonicamid Cotton Field Development Program across the southern and western regions of the US.

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Table 1. Efficacy of Flonicamid versus carbamate, pyrethroid and organochlorine insecticides against cotton aphid (*Aphis gossypii*) in cotton. [a]

			Percent Control [b]	
Treatment [d]	**lb ai/a**	**g ai/ha**	**3 [c]**	**7**
Flonicamid	0.022	25	92	90
	0.044	50	97	98
	0.066	75	98	98
	0.088	100	99	94
Carbofuran	0.25	280	100	100
Bifenthrin + Endosulfan	0.1+1.0	112 + 1120	100	--
Untreated [e]			102	43

[a] Data from 2 replicated field trials conducted during 2001 in North America, FMC research.
[b] Percent control based on untreated.
[c] Days after applications.
[d] Treatments applied at local threshold.
[e] Values are average pests / leaf.

Table 2. Efficacy of Flonicamid versus neonicotinoid, organophosphate and other insecticides against cotton aphid (*Aphis gossypii*) in cotton. [a]

			Percent Control [b]							
Treatment [d]	**lb ai/a**	**g ai/ha**	**1-3 [c]**	**(n)[e]**	**6-10**	**(n)**	**12-15**	**(n)**	**18-22**	**(n)**
Flonicamid	0.036	40	70.2	(4)	80.2	(3)	84.1	(3)	--	--
	0.053	60	82.8	(6)	82.1	(8)	79.5	(7)	67.7	(5)
	0.071	80	81.1	(6)	84.2	(8)	87.7	(7)	87.1	(5)
	0.088	100	85.7	(7)	85.6	(12)	87.9	(11)	87.0	(7)
Thiamethoxam	0.047	53	76.7	(7)	79.1	(8)	62.7	(7)	81.0	(2)
Acetamiprid	0.050	56	89.8	(7)	87.0	(6)	89.8	(4)	38.0	(2)
Pymetrozine	0.125	140	39.3	(2)	20.8	(1)	--	--	--	--
Imidacloprid	0.031	35	93.8	(1)	91.0	(4)	43.9	(4)	53.8	(2)
	0.047	53	72.9	(3)	56.9	(3)	--	--	--	--
Carbofuran	0.25	280	94.5	(2)	88.8	(6)	56.5	(5)	49.3	(4)
Dicrotophos	0.4	448	32.3	(2)	21.9	(1)	--	--	--	--
Untreated [f]			105.1	(6)	112.2	(8)	78.6	(9)	23.9	(4)

[a] Data from eight replicated field trials conducted during 2002 in North America contract, university and FMC research.
[b] Percent control based on untreated.
[c] Days after applications.
[d] Treatments applied at local threshold.
[e] Number of observations in mean.
[f] Values are average pests / leaf.

Table 3. Efficacy of Flonicamid against Cotton Aphid (*Aphis gossypii*) in cotton. [a]

			Percent Control [b]							
Treatment	**lb ai /a**	**g ai/ha**	**2- 4[c]**	**(n)[d]**	**5 - 7**	**(n)**	**11 - 15**	**(n)**	**21**	**(n)**
Flonicamid	0.018	20	86	(8)	85	(10)	81	(8)	66	(2)
	0.027	30	94	(8)	87	(10)	82	(8)	49	(2)
	0.036	40	81	(10)	81	(12)	84	(8)	68	(2)
	0.044	50	94	(8)	89	(10)	88	(8)	68	(2)
	0.054	60	82	(10)	88	(12)	83	(8)	66	(2)
	0.071	80	41	(2)	59	(2)	--	--	--	--
Thiamethoxam	0.05	56	92	(5)	97	(6)	80	(4)	24	(1)
Acetamiprid	0.05	56	79	(1)	96	(1)	--	--	--	--
Untreated[e]			379	(5)	341	(5)	79	(3)	23	(1)

[a] Six 2003 North American field trials reported.
[b] Percent control based on untreated.
[c] Days after application.
[d] Number of observations in mean.
[e] Number of pests per 10 leaves.

Table 4. Efficacy of Flonicamid against Cotton Aphid (*Aphis gossypii*) in cotton. [a]

			Percent Control[b]									
Treatment	**lb ai /a**	**g ai/ha**	**3[c]**	**(n)[d]**	**5-7**	**(n)**	**10**	**(n)**	**14**	**(n)**	**21**	**(n)**
Flonicamid	0.027	30	81	(6)	86	(8)	94	(6)	89	(6)	75	(2)
	0.044	50	81	(6)	88	(8)	93	(6)	93	(6)	88	(2)
	0.063	70	86	(6)	92	(8)	96	(6)	94	(6)	87	(2)
Thiamethoxam	0.047	53	80	(3)	90	(4)	82	(3)	84	(3)	35	(1)
Acetamiprid	0.05	56	87	(3)	92	(4)	93	(3)	93	(3)	91	(1)
Untreated[e]			241	(3)	247	(4)	197	(3)	117	(3)	62	(1)

[a] Four 2003 North American field trials reported.
[b] Percent control based on untreated.
[c] Days after application.
[d] Number of observations in mean.
[e] Number of pests per 10 leaves.

Table 5. Efficacy of Flonicamid Formulations against Cotton Aphid (*Aphis gossypii*) in university cotton trials. [a]

			Percent Control[b]					
Treatment	**lb ai /a**	**g ai/ha**	**1- 3[c]**	**(n)[d]**	**5 - 9**	**(n)**	**12 - 15**	**(n)**
Flonicamid	0.054	60	62	(8)	72	(4)	63	(2)
	0.071	80	56	(8)	87	(5)	78	(3)
Acetamiprid	0.05	56	81	(8)	93	(4)	88	(2)
Imidacloprid	0.047	53	57	(9)	68	(7)	46	(4)
Thiamethoxam	0.05	56	71	(8)	82	(4)	32	(2)
Thiacloprid	0.047	53	58	(2)	21	(1)	71	(1)
Imidacloprid + Cyfluthrin	0.079	88	71	(2)	65	(1)	4	(1)
NTN-33893 1.67OD	0.047	53	59	(2)	21	(1)	24	(1)
NTN-33893 2.0OD	0.056	63	72	(2)	90	(1)	22	(1)
Carbofuran	0.25	280	94	(2)	83	(1)	38	(1)
Dicrotophos	0.25	280	64	(3)	33	(2)	42	(1)
Profenofos	0.5	560	53	(2)	54	(1)	0	(1)
Chlorpyrifos	0.75	840	78	(2)	72	(1)	0	(1)
Oxamyl	0.75	840	74	(2)	45	(1)	0	(1)
Untreated [e]			58	(7)	18	(6)	17	(3)

[a] Eight 2003 North American field trials reported.
[b] Percent control based on untreated.
[c] Days after application.
[d] Number of observations in mean.
[e] Number of pests per 10 leaves.

Table 6. Efficacy of Flonicamid against Cotton aphid (*Aphis gossypii)* in cotton. [a]

			Percent Control [b]					
Treatment	**lb ai /a**	**g ai/ha**	**1- 3[c]**	**(n)[d]**	**4 - 7**	**(n)**	**8 - 15**	**(n)**
Flonicamid	0.044	50	88	(12)	88	(20)	91	(20)
	0.054	60	69	(18)	89	(16)	75	(12)
	0.063	70	87	(12)	95	(16)	95	(24)
Imidacloprid	0.047	53	79	(5)	70	(3)	55	(4)
Thiamethoxam	0.05	56	78	(15)	94	(13)	73	(14)
Acetamiprid	0.05	56	82	(12)	93	(7)	92	(10)
Pymetrozine	0.086	96	--	--	81	(2)	96	(1)
Untreated [e]			78	(15)	48	(17)	15	(15)

[a] Eighteen 2003 North American field trials reported.
[b] Percent control based on untreated.
[c] Days after application.
[d] Number of observations in mean.
[e] Number of pests per 10 leaves or terminals.

Table 7. Comparative efficacy of Flonicamid on Cotton Aphid (*Aphis gossypii), 2*001-2003.[a]

			Percent Control [b]							
Treatment	**lb ai /a**	**g ai/ha**	**1- 3[c]**	**(n)[d]**	**6-10**	**(n)**	**11-15**	**(n)**	**18-22**	**(n)**
Flonicamid	0.044	50	86	(21)	89	(22)	90	(14)	77	(4)
	0.054	60	77	(31)	83	(26)	79	(18)	67	(9)
	0.063	70	88	(16)	96	(24)	93	(12)	90	(4)
Imidacloprid	0.047	53	60	(12)	65	(10)	46	(4)	29	(2)
Thiamethoxam	0.05	56	81	(26)	85	(25)	68	(17)	62	(7)
Acetamiprid	0.05	56	87	(22)	92	(18)	90	(9)	65	(4)
Dicrotofos	0.25		68	(4)	28	(6)	31	(5)	32	(2)
Carbofuran	0.25		96	(5)	89	(8)	53	(6)	49	(4)
Untreated[e]			53	(40)	49	(41)	40	(23)	25	(9)

[a] Overall analysis of 35 North American field trials.
[b] Percent control based on untreated.
[c] Days after application.
[d] Number of observations in mean.
[e] Number of pests per 10 leaves or terminals.

Table 8. Efficacy of Flonicamid versus neonicotinoid and pyrethroid insecticides against tarnished plant bug (*Lygus lineolaris*) in cotton. [a]

Treatment [d]	lb ai/a	g ai/ha	Percent Control - Adults + Nymphs [b] 1-4 [c]	6-10	13-16	20-22
Flonicamid	0.036	40	57.5	47.2	79.2	91.7
	0.053	60	57.9	51.7	82.2	91.7
	0.071	80	46.6	53.5	84.8	83.3
	0.088	100	51.9	70.4	85.3	100.0
Zetacypermethrin	0.016	18	81.8	84.5	78.8	66.7
Acetamiprid	0.05	56	59.1	41.1	61.7	75.0
Thiamethoxam	0.063	70	69.2	48.8	58.5	66.7
Imidacloprid + Cyfluthrin	0.037 + 0.026	41 + 29	75.0	57.2	68.2	50.0
Untreated[e]			5.4	2.9	1.7	1.0
			% Square Retention			
Flonicamid 50DF	0.036	40	72.0	58.7	58.7	58.7
	0.053	60	69.3	66.7	66.7	66.7
	0.071	80	73.3	61.3	61.3	61.3
	0.088	100	75.0	69.3	69.3	69.3
Zetacypermethrin	0.016	18	80.0	74.7	74.7	74.7
Acetamiprid	0.05	56	72.0	69.3	69.3	61.3
Thiamethoxam	0.063	70	70.7	64.0	64.0	61.3
Imidacloprid + Cyfluthrin	0.037 + 0.026	41 + 29	73.3	64.0	64.0	61.3
Untreated[e]			69.3	64.0	64.0	58.7

[a] Data from two replicated field trials conducted during 2002 in North America university research.
[b] Percent control based on untreated.
[c] Days after applications.
[d] Treatments applied at local threshold.
[e] Values are average pests / 50 sweeps.

Table 9. Efficacy of Flonicamid Formulations against Tarnished Plant bug (*Lygus lineolaris*) in cotton. [a]

			Percent Control [b] Nymphs						Adults					
Treatment	lb ai /a	g ai/ha	2-3[c]	(n)[d]	7	(n)	10	(n)	2-3[c]	(n)[d]	7	(n)	10	(n)
Flonicamid	0.036	40	2	(2)	0	(2)	40	(2)	9	(2)	8	(2)	0	(2)
	0.054	60	66	(6)	65	(6)	34	(2)	65	(6)	50	(6)	75	(2)
	0.071	80	64	(6)	51	(6)	55	(2)	51	(6)	3	(6)	0	(2)
	0.088	100	47	(4)	40	(4)	64	(2)	37	(4)	0	(4)	93	(2)
Acetamiprid	0.05	56	0	(1)	12	(1)	58	(1)	0	(1)	16	(1)	0	(1)
Imidacloprid	0.047	53	100	(2)	100	(2)	--	--	90	(2)	94	(2)	--	--
Thiamethoxam	0.05	56	81	(3)	81	(3)	75	(1)	60	(3)	96	(3)	0	(1)
Acephate	0.5	560	90	(3)	79	(3)	68	(1)	27	(3)	66	(3)	0	(1)
Untreated[e]		74	(3)	81	(3)	238	(1)	10	(3)	5	(3)		8	(1)

[a] Three 2003 North American university field trials reported.
[b] Percent control based on untreated.
[c] Days after application.
[d] Number of observations in mean.
[e] Number of pests per 100 row ft or 40 sweeps

Table 10. Efficacy of Flonicamid versus neonicotinoid and pyrethroid insecticides against western plant bug (*Lygus hesperus*) in cotton. [a]

Treatment [d]	lb ai/a	g ai/ha	Percent Control - Adults [b] 1-4 [c]	6-10	13-16	20-22
Flonicamid	0.036	40	43.0	67.9	71.9	71.3
	0.053	60	59.7	46.7	39.4	58.0
	0.071	80	67.6	57.1	64.0	31.3
	0.088	100	61.8	54.3	43.2	50.9
Zetacypermethrin	0.016	18	100.0	86.5	60.9	67.4
Acetamiprid	0.05	56	60.6	71.5	58.2	51.8
Thiamethoxam	0.063	70	62.6	57.4	53.1	29.2
Imidacloprid + Cyfluthrin	0.037 + 0.026	41 + 29	83.5	83.1	36.6	66.0
Untreated[e]			5.5	6.7	6.3	7.8
			Percent Control - Nymphs			
Flonicamid	0.036	40	67.0	75.4	60.8	93.2
	0.053	60	80.8	77.0	59.4	71.7
	0.071	80	72.5	68.2	64.0	84.3
	0.088	100	74.0	81.6	64.9	82.9
Zetacypermethrin	0.016	18	53.4	50.7	54.4	85.7
Acetamiprid	0.05	56	57.5	72.4	78.2	74.8
Thiamethoxam	0.063	70	50.0	46.5	34.9	57.9
Imidacloprid + Cyfluthrin	0.037 + 0.026	41 + 29	35.8	52.9	38.8	66.9
Untreated[e]			2.6	4.6	3.8	6.9

[a] Data from two replicated field trials conducted during 2002 in North America university research.
[b] Percent control based on untreated.
[c] Days after applications.
[d] Treatments applied at local threshold.
[e] Values are average pests / 50 sweeps.

Table 11. Efficacy of Flonicamid Formulations against Western Plant bug (*Lygus hesperus*) in cotton. [a]

			Percent Control [b]											
			Nymphs						Adults					
			1st Application			2nd Application			1st Application			2nd Application		
Treatment	lb ai /a	g ai/ha	3[c]	7	10	3	6	10	3[c]	7	10	3	6	10
Flonicamid	0.036	40	50	46	71	88	83	57	42	32	13	65	38	71
	0.054	60	38	50	63	98	90	54	44	13	0	61	19	35
	0.071	80	38	46	59	82	94	72	40	44	19	75	25	69
	0.088	100	50	50	71	88	93	78	34	44	13	84	25	63
Thiamethoxam	0.05	56	25	50	33	28	58	38	34	50	0	38	25	23
Acetamiprid	0.05	56	0	42	50	23	64	50	46	75	0	50	50	15
Acephate	0.5	560	50	50	67	95	100	94	29	0	0	46	50	62
Untreated [d]			0.5	1.0	1.3	2.8	4.0	2.0	2.5	1.3	0.8	2.3	0.8	2.3

[a] One 2003 North American university field trial reported.
[b] Percent control based on untreated.
[c] Days after respective application.
[d] Number of pests per 50 sweeps.