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CARBINETM – A NEW INSECTICIDE FOR FOLIAR PEST MANAGEMENT IN COTTON

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Abstract

Carbine ™ (flonicamid, F1785, IKI-220) is being co-developed by Ishihara Sangyo Kaisha, Ltd. and FMC Corporation and will be marketed by FMC in U.S. cotton. Carbine is a member of the new class of chemistry, the Pyridinecarboxamides, and laboratory testing has demonstrated lack of cross-resistance to all known insecticide classes, including the neonicotinoids. Results from extensive field and laboratory trials conducted since 2001 shows excellent residual control of cotton aphids with no effect on predators and parasites. At rates of 0.044 – 0.088 lbs ai/acre, Carbine provides control of *Lygus* spp. comparable to the neonicotinoid standards. US-EPA is currently reviewing this product and registration is expected in time for the 2006 cotton season.

Introduction

Flonicamid (F1785, IKI-220) is a novel and exciting new insecticide discovered by ISK Corporation. In 2001, FMC Corporation obtained exclusive rights to develop, market, and distribute this new product in North America and parts of Latin America. In North America, flonicamid will be sold under the trade name Carbine in cotton. Extensive laboratory research has shown that flonicamid is a unique mode of action and does not affect the nicotinic receptor site that is the key target for the many neonicotinoid insecticides presently registered and used in several crops, including cotton. In addition, the research has shown no effect on target sites associated with any of the other known insecticide classes, and has given no indications of potential cross-resistance to all other classes in the studies. Laboratory and field research has also shown the tremendous potential for Carbine as an ideal IPM and IRM tool due to the extreme selectivity on only the pest species and the aforementioned lack of cross-resistance to other cotton pest management products.

Development activities in North America by FMC Corporation since 2001 have generated data from over 400 field research trials across a variety of crops and use patterns. In cotton, research has concentrated on the investigation of sucking pest activity and residual control on several key pests in the crop at locations across the cotton belt. Much of the research has concentrated on the cotton aphid (*Aphis gossypii* Glover) and on the complex of plant bugs, including *Lygus lineolaris* Palisot del Beavois and *Lygus hesperus* Knight. Research in 2003 and 2004 concentrated on management of the cotton aphid, with results showing excellent efficacy at 7 days after treatment with residual control up to 21 days that is rate-dependent. Other more preliminary work gave strong indications of activity on the plant bug complex in cotton, which was the key objective of the 2004 FMC research program in North America, with those additional results to be presented here.

Materials and Methods

Field Trials - Aphids

Replicated field trials were conducted on cotton aphid from 2001 to 2004 at various rates up to 0.088 lb ai/A (100 gm ai/ha). Trials were located across the cotton belt with university, contract research, and FMC internal researchers. Cotton aphid counts were taken at 3, 7, 15, and 21 days after application to determine initial and residual capabilities in comparison to the standards acetamiprid, imidacloprid, thiamethoxam, acephate, pymetrozine, carbofuran, and dicrotophos.

Field Trials - Plant Bugs

Replicated field trials were also conducted on the plant bug complex in cotton in 2002 through 2004 with locations in the key states showing consistent and increasing yield and quality losses from this insect complex in recent years as broad-spectrum foliar insecticide use has declined due to increase in Bt varieties. The majority of work was carried out in the states of AL, AR, GA, MS, and LA on Tarnished plant bug, *Lygus lineolaris* Palisot del Beavois. Trials were typically conducted with a minimum of 4 replications in a randomized complete block design. Treatments were applied via small plot sprayer, backpack or tractor-mounted, using either hollow-cone or flat fan nozzles that were delivered in a 10 to 15 gallon per acre spray volume. 2003 trials utilized standard small plot parameters, generally 4 rows in width and 50 to 100 feet in length with the middle two rows receiving the treatment. Plot size in the 2004 consisted of plot areas above average in size to account for the mobile nature of the pest. Most 2004 sites were at least 10 rows in width and 100 m in length. Applications were applied to the middle 6 rows with 2 rows of buffer on each side. Plant bug counts were made with varying methods, but generally were conducted using beat cloth or sweep net sampling techniques. In 2004, trials received two applications of each treatment at 10-day intervals timed at threshold. Data were taken at 3, 7, 15, and 21 days after each treatment, and all plots were harvested for yield analysis.

Results and Discussion

Results - Aphids

Flonicamid efficacy trials conducted by FMC internal research and through university and contract research from 2001 through 2004 has provided a robust data set indicating the attributes and use parameters for foliar flonicamid use on cotton aphids and various plant bug pest species. On cotton aphid, the research summary across all years shows clearly that flonicamid at rates of 0.053 to 0.063 lb ai/A gives initial and residual control from 3 to 15 days after application that is comparable to the competitive standards thiamethoxam (0.047 lb ai/A) and acetamiprid (0.05 lb ai/A), and superior performance when compared to imidacloprid (0.047 lb ai/A). (Table 1.)

Table 1. Control of cotton aphid, Aphis *gossypii* Glover, at various days after treatment (DAT) with Flonicamid and competitive standards. Summarized data from 2001 to 2004 U.S. field trials.

Treatment	Percent Control Cotton Aphid		
	1-3 DAT	5-7 DAT	7-15 DAT
Flonicamid 0.053 lb ai/A	80	90	84
Flonicamid 0.063 lb ai/A	78	94	98
Thiamethoxam 0.047 lb ai/A	78	85	83
Acetamiprid 0.05 lb ai/A	92	90	92
Imidacloprid 0.047 lb ai/A	81	65	71

Results - Plant Bug

Flonicamid research on plant bug efficacy in cotton was a key objective in the 2004 research season to build upon results from the 2002 and 2003 seasons. 2004 research was focused on the documentation of flonicamid effects on insect biology and subsequent benefits on cotton fruit set and yields. Results showed that flonicamid at 0.053 and 0.063 lb ai/A reduced plant bug nymph populations beginning at 7 days after the first application equivalent to control levels seen with acetamiprid, thiamethoxam, and acephate, and superior to that seen with imidacloprid. Counts at 3, 7, and 10 days after the second application showed percent control from either flonicamid rate comparable to that of thiamethoxam or acephate, and superior to control levels given by acetamiprid or imidacloprid on plant bug nymphs (Table 2). Plant bug adult data from the trials showed relatively higher levels of adult control with both flonicamid rates, superior at 7 days after the first and second application than the competitive standards (Table 3).

Summary data from the plant bug trials on final lint yield comparisons between treatments clearly reflects the plant protection benefits flonicamid delivers in the management of plant bugs. When compared to the untreated check, flonicamid gave the highest yield increase over the untreated check, followed by thiamethoxam, acephate, imidacloprid, and acetamiprid, respectively (Table 4).

Table 2. Control of plant bug nymphs, *Lygus lineolaris* Palisot del Beavois, with Flonicamid and competitive standards at various days after each treatment (DAT 1 or 2). Summarized data from 2002 to 2004 U.S. field trials.

Treatment	Percent Control - Plant Bug Nymphs					
	Days after Treatment / Treatment Number					
	1-3 DAT 1	7 DAT 1	10 DAT 1	1-3 DAT 2	7 DAT 2	10 DAT 2
Flonicamid 0.054 lb ai/A	59	56	63	69	63	65
Flonicamid 0.063 lb ai/A	56	62	65	61	63	61
Thiamethoxam 0.05 lb ai/A	45	59	49	66	64	65
Imidacloprid 0.047 lb ai/A	43	52	47	50	51	40
Acetamiprid 0.05 lb ai/A	46	65	42	58	54	47
Acephate 0.485 lb ai/A	50	64	52	60	64	58

Table 3. Control of plant bug adults, *Lygus lineolaris* Palisot del Beavois, with Flonicamid and competitive standards at various days after each treatment (DAT 1 or 2). Summarized data from 2002 to 2004 U.S. field trials.

Treatment	Percent Control - Plant Bug Nymphs					
	Days after Treatment / Treatment Number					
	1-3 DAT 1	7 DAT 1	10 DAT 1	1-3 DAT 2	7 DAT 2	10 DAT 2
Flonicamid 0.054 lb ai/A	52	71	69	64	68	64
Flonicamid 0.063 lb ai/A	62	76	78	65	73	70
Thiamethoxam 0.05 lb ai/A	56	56	40	68	56	59
Imidacloprid 0.047 lb ai/A	45	56	56	54	45	65
Acetamiprid 0.05 lb ai/A	46	56	62	69	58	49
Acephate 0.485 lb ai/A	60	63	59	67	63	62

Table 4. 2004 cotton plant bug trials, increase in lint yield over the untreated check by treatment, summarized data from all trials.

Treatment	Pounds increased lint production over untreated check
Flonicamid	129
Thiamethoxam	110
Acephate	89
Imidacloprid	71
Acetamiprid	64

Conclusions

The research conducted from 2001 through 2004 clearly shows the significant pest management potential that flonicamid offers in cotton production. As a foliar treatment, flonicamid will provide an effective pest management tool for cotton aphids and plant bugs. Flonicamid is highly effective as an insect management tool while offering the additional benefits of exceptional beneficial predator and parasite safety and conservation, minimal impact on the environment and non-target organisms, and an ideal fit in an insecticide resistance management program due to the unique mode of action. With the predominance of neonicitinoid product use for this pest complex in cotton, it will become increasingly important to have alternative choices in the their management for optimal conservation of all insecticide management tools to facilitate long term sustainability of control options.

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References

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