DEVELOPMENT OF SULFOXAFLOR FOR MANAGEMENT OF COTTON PESTS IN ASIA

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Abstract

Sulfoxaflor is the first member of a new chemical class of insecticides, the sulfoximines. Development of sulfoxaflor for control of sap-feeding pests in Asia began in 2007. Subsequent trials in China, Pakistan and India demonstrated excellent efficacy against key pests such as jassids, *Lygus* bugs, cotton aphid and whiteflies. Rates of 25-75 g ai/ha, depending on pest and geography, were very effective relative to current commercial standards used in cotton.

Introduction

Cotton is an important cash crop in China and the central Asian countries of Pakistan and India. As in other cotton producing areas, insect pests can be a significant limiting factor on production. *Bt* cotton has been extensively introduced throughout Asia and has resulted in a significant reduction in insecticides required for control of various lepidopteran pests. However, a complex of sap-feeding pests, the composition of which varies in different areas, has become increasingly important.

In China, the most important sap-feeding pest is the plant bug *Lygus lucorum*. As in other areas where *Lygus* bugs and related pests in the family Miridae are cotton pests, *Lygus* in China feed on developing cotton fruit, causing squares to drop from plants and resulting in yield loss. In India and Pakistan, leafhoppers known as jassids (*Amrasca devastans*) are among the most important sap-feeders. These insects feed on sap from leaves and inject toxins, reducing the photosynthetic ability of plants and causing leaves to curl, turn yellow then brown, and ultimately drop from plants. Severe jassid infestations may kill plants. The cotton mealybug, *Phenacoccus solenopsis,* was devastating to cotton crops in India and Pakistan shortly after the introduction of *Bt* cotton, although infestations have declined in severity in recent years. Mealybugs weaken plants as a result of feeding on leaves, stems and fruit, and produce large amounts of honeydew which may induce development of severe sooty mold and staining. Across all these areas, the cotton aphid (*Aphis gossypii*) and whiteflies (*Bemisia tabaci*) may also be significant pests, weakening plants and producing honeydew and sooty mold.

Sulfoxaflor, the first member of a new chemical class of insecticides, the sulfoximines (Babcock et al. 2011), was first tested for control of various Asian cotton pests in 2007. Numerous trials were subsequently carried out in all major cotton-growing regions, demonstrating that sulfoxaflor has an excellent fit for control of the sap-feeding pest complex. This paper summarizes trials on jassids, mealybugs, *Lygus* and whiteflies in Asia cotton.

Methods

All trials reported here used standard small-plot methods. Details specific to each set of trials are as follows.

Jassid Trials (Pakistan)

A total of 16 trials are summarized. All were randomized complete block experiments with four replications. Plot size ranged from 36-64 m^2. Applications were made with a hand-operated knapsack sprayer calibrated to deliver 200 l/ha spray volume. At each assessment period, the number of adults and nymphs were counted on 15 randomly selected leaves per plot.

Mealybug Trials (Pakistan)
A total of seven trials are summarized. All were randomized complete block experiments with four replications. Plot size ranged from 36-64 m^2. At each assessment period, the number of mealybugs was counted on 7.5 cm of the terminal portion of 5 plants in each plot.

Jassid trials (India)
A total of 19 trials are summarized. All were randomized complete block experiments with three replications. Plots size ranged from 65-75 m^2 and spray volume was 500 l/ha. At each assessment, the number of jassids was counted on 50 leaves per plot.

Mealybug trials (India)
A total of 16 trials are summarized. All were randomized complete block experiments with three replications. Plots size ranged from 65-75 m^2 and spray volume was 500 l/ha. At each assessment, the number of mealybugs on a 6 inch section of stem was counted on 10 plants per plot.

***Lygus* trials (China)**
A total of 7 trials are summarized. All were randomized complete block experiments with four replications. Plot size ranged from 40-60 m^2. A single foliar application was made using a spray volume of 675-900 l/ha. At various intervals after application, 10 plants were sampled in each plot, and the number of *Lygus* and damaged squares were counted.

Whitefly trials (China)
A total of 7 trials are summarized. All were randomized complete block experiments with four replications. Plot size was 30 m^2. Two foliar applications were made using a spray volume of 675-900 l/ha. At various intervals after application, 10 plants were sampled in each plot, and the number of whiteflies (mixed population of nymphs, pupae and adults) was counted.

Results

Sulfoxaflor provided excellent control of jassids in Pakistan trials (Table 1). Good efficacy was evident by 3-4 days after application, and sulfoxaflor at 25 g ai/ha was similar to the best commercial standards in initial control; residual control provided by sulfoxaflor was better than all commercial standards tested. Similar results were obtained for mealybugs (Table 1), although 38 g ai/ha was required to match the residual efficacy of profenofos at 1250 g ai/ha.

Sulfoxaflor also provided excellent control of jassids in India trials (Table 2). Relatively higher rates than in Pakistan were required, but sulfoxaflor at 50-75 g ai/ha provided equal or better control than standards. Higher rates were required for mealybug control in India as well. Against mealybugs in India, 50 g ai/ha did not provide adequate control relative to standards. However, 75 g ai/ha provided improved residual control relative to standards. Most products required 7 days for optimum mealybug control in India.

Table 1. Efficacy of sulfoxaflor and standards for control of jassid and mealybug in Pakistan; 16 jassid trials and 7 mealybug trials summarized.

Treatment	Rate[1]	% Jassid Control			% Mealybug Control		
		3-4 DAA[2]	9-11 DAA	14-15 DAA	3 DAA	7 DAA	10 DAA
Sulfoxaflor	25	87.3	81.2	75.3	77.0	76.5	79.3
Sulfoxaflor	37.5	89.5	88.0	80.2	80.9	84.9	84.7
Sulfoxaflor	50	90.3	90.0	80.7	84.3	83.9	84.5
Spirotetramat	75	30.6	30.8	NA	--	--	--
Imidacloprid	50	62.6	47.8	26.3	--	--	--
Acephate	469	89.9	86.4	40.1	--	--	--
Nitenpyram	50	81.2	84.8	65.4	--	--	--
Acetamiprid	62.5	--	--	--	73.9	62.2	70.3
Chlorpyrifos	1250	--	--	--	53.7	66.9	61.8
Profenofos	1250	--	--	--	74.0	85.9	84

[1]Rate in g ai/ha.
[2]Days after application.

Table 2. Efficacy of sulfoxaflor and standards for jassid and mealybug control in India, 2007-2011; 19 trials summarized for jassids, 16 for mealybugs.

Treatment	Rate[1]	% Jassid Control				% Mealybug Control			
		3DAA[2]	7 DAA	10 DAA	14 DAA	7 DAAA[3]	14 DAAA	7 DAAB	14 DAAB
Sulfoxaflor	25	51	53	52	58	--	--	--	--
Sulfoxaflor	50	64	82	75	57	28	23	47	35
Sulfoxaflor	75	54	78	76	76	59	77	68	86
Sulfoxaflor	90	67	87	82	85	--	--	--	--
Sulfoxaflor	100	--	--	--	--	71	91	73	97
Imidacloprid	75	54	67	62	68	--	--	--	
Imidacloprid	140	--	--	--	--	32	34	49	44
Monocrotophos + Acephate	600 750	75	80	67	68	--	--	--	--
Profenofos + Cypermethrin	625 62.5	--	--	--	--	59	57	58	48

[1]Rate in g ai/ha.
[2]Days after application.
[3]DAAA = days after application A; DAAB = days after application B.

In trials in China, sulfoxaflor provided excellent control of *Lygus* bugs. At 38 g ai/ha it was similar to the commercial standard of malathion at 600 g ai/ha and higher rates provided improved residual control (Table 3). Sulfoxaflor also provided good control of whiteflies in China (Table 4), although higher rates were required relative to the commercial standard, acetamiprid. Typically, two applications are required for optimum whitefly performance.

Table 3. Efficacy of sulfoxaflor and malathion for *Lygus* control in China (summary of 7 trials).

Treatment	Rate[1]	% Control at Day After Application		
		1	3	7
Sulfoxaflor	38	76	79	77
Sulfoxaflor	50	75	86	84
Sulfoxaflor	75	82	91	83
Malathion	600-680	74	83	76

[1]Rate in g ai/ha.

Table 4. Efficacy of sulfoxaflor and acetamiprid for whitefly (*Bemisia* spp.) control in China (summary of 7 trials).

Treatment	Rate[1]	% Control at Day After Second Application		
		3	7	11
Sulfoxaflor	50	76	79	77
Sulfoxaflor	75	75	86	84
Sulfoxaflor	100	82	91	83
Acetamiprid	30	74	83	76

[1]Rate in g ai/ha.

Summary

Sulfoxaflor has an excellent fit for management of cotton pests in Asia. It has demonstrated outstanding control of key pests such as jassids and mealybugs, and also has good activity on whiteflies in many areas. Although not detailed in this paper, sulfoxaflor has provided excellent control of cotton aphids as well, similar to results seen in the US (Castro et al. 2010); likewise, it is very effective for *Lygus* spp. control in the US (Siebert et al. 2010). Sulfoxaflor has also demonstrated a lack of cross resistance to other insecticides in a number of insecticide-resistant populations resistant to a variety of other chemistries, such as neonicotinoids, pyrethroids, organophosphates and carbamates (Babcock et al. 2011, Zhu et al. 2011).

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