UTILITY OF FULFILL 50 WG FOR APHID AND WHITEFLY MANAGEMENT IN COTTON

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Abstract

Fulfill™ is a selective new insecticide currently under development by Novartis Crop Protection. It contains the active ingredient, pymetrozine, which belongs to a new chemical class known as the pyridine azomethines. Pymetrozine exhibits a unique mode of action and is not known to be cross-resistant to any other class of chemistry. It will have utility in insect pest management in cotton because of its activity against both aphids and whiteflies. Fulfill is compatible for use in cotton IPM and resistance management programs because of it's selectivity, low use rate, and unique mode of action. Novartis Crop Protection recently submitted a petition to EPA requesting registration of Fulfill as a reduced risk pesticide on several crop groupings, including fruiting vegetables, cucurbit vegetables, tobacco, and potatoes. Petitions for cotton, cole crops, and leafy vegetables are expected to be submitted in the third quarter of 1998.

Introduction

Fulfill™ is a selective new insecticide with activity against some important sucking insect pests in cotton. The active ingredient in Fulfill is pymetrozine, an insecticidal compound which belongs to a new chemical class known as pyridine azomethines. Fulfill has excellent activity against a wide range of aphid species that are pests of many major cropping systems, including the cotton aphid, *Aphis gossypii*. Fulfill is also active against a number of whitefly species, especially the adult life stage; activity against immature stages of whitefly is more limited. Because of this, Fulfill will not be recommended as a stand-alone product for whitefly control in cotton. However, it will have utility as a tank-mix partner, especially with some of the newer IGR materials which are especially active against immatures, but not against adults.

Mode of Action and Uptake

Pymetrozine exhibits a unique mode of action which can be characterized as neural inhibition of feeding behavior. It does not have a general toxic or paralyzing effect on insects, but selectively interferes with normal feeding activities by affecting the neural regulation of fluid intake. There is no knockdown effect after exposure to pymetrozine: affected insects stop feeding shortly after exposure, which consequently results in mortality due to starvation after 2-5 days. It is postulated that pymetrozine affects the activity of the cibarial muscles, the food pump, and the salivary pump (Harrewijn, 1997). No other insecticide is known to cause a selective inhibition of feeding without paralyzing the insect.

Fulfill is readily taken up into plant foliage after spray application, making it less susceptible to removal by rainfall compared to pesticides which do not move across the leaf surface and into plant tissue. Because of this translaminar activity, Fulfill is effective against aphids and whiteflies which feed on both the upper and lower surfaces of leaves. Fulfill also demonstrates significant plant systemic activity. Recent autoradiographic studies (Wyss and Bolsinger, 1997) suggest excellent acropetal translocation of Fulfill within the xylem, and more limited basipetal movement within the phloem. Fulfill typically exhibits residual activity for a period of 2-3 weeks.

IPM Compatibility

Fulfill has excellent potential for utility in integrated pest management programs because of its selectivity, low use rate, and unique mode of action.

Fulfill is a highly selective insecticide, and has been shown to be safe to many common predators, parasitoids, and pollinators. Results from selectivity tests with pymetrozine under laboratory and greenhouse conditions have shown it to be selective for practically all beneficial groups according to the International Organization for Biological and Integrated Control of Noxious Animals and Plants (IOBC) selectivity rating system (Sechser, 1996). The following beneficial insects, which are commonly found in cotton, have been assigned an IOBC rating of 1, which indicates that the compound is considered harmless (<30% mortality): green lacewings, seven-spotted lady beetles, carabid beetles, *Orius spp.*, *Geocoris spp.*, syrphid flies, predatory mites and *Encarsia spp.*

Fulfill is applied at very low use rates ranging from 0.086 lbs ai/A- 0.172 lbs ai/A; these rates are lower than many products that are currently used for aphid and whitefly control in cotton. Fulfill is applied as a foliar spray only in response to the presence of insect pest populations on plants. Thus, Fulfill can be used in integrated pest management programs which encourage field scouting and the use of economic thresholds to ensure correct timing of insecticide applications. Although economic thresholds for aphids and whiteflies have not been widely used in cotton in the past, they are being developed by university researchers in several major production areas.

Cross Resistance and Resistance Management

The cotton aphid has a long history worldwide of developing resistance to insecticides; resistance to multiple

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chemical classes in the cotton aphid has been documented by several researchers (Devonshire, 1989, Georghiou, 1981). Because of pymetrozine's unique mode of action, the estimated risk for developing cross-resistance to other insecticides is considered rather low. Laboratory investigations carried out with 11 *Aphis gossypii* clones from around the world revealed that responses to pymetrozine bore no apparent relationship to the resistance status of strains of *A. gossypii* to several insecticide classes, including OP's, carbamates, and pyrethroids. Laboratory trials with 10 *Bemisia tabaci* clones (5 B and 5 non-B biotype) revealed no obvious relationships to existing patterns of insecticide resistance. In addition, there was no clear-cut association between susceptibility to pymetrozine and the biotype status of whitefly populations (Denholm et al., 1994). In several field trials, pymetrozine showed good activity and no cross-resistance against organophosphate and pyrethroid resistant strains of *Aphis gossypii* in vegetables, and buprofezin resistant *Bemisia tabaci* on tomatoes and cucumbers (Novartis internal communication).

The directions for use for Fulfill on cotton will limit the number of applications to two per crop per season. Limiting the number of applications of Fulfill will encourage its use within the context of an aphid management program which utilizes alternation with other classes of insecticides as well as other management options. For example, imidacloprid is an effective new chloronicotinyl insecticide that is used at planting or as a foliar treatment for control of sucking insect pests in cotton. Fulfill could effectively be used as a foliar treatment following an at-planting application of imidacloprid when the effective residual of that compound has diminished. The judicious alternation of these two different modes of action could provide the foundation for effective cotton aphid control for years to come. In addition, this novel mode of action could be integrated into resistance management strategies through tank-mixing with other modes of action.

Fulfill can be integrated into pest management programs which utilize transgenic cotton as one component of an overall pest management program. Several varieties of cotton are now available which contain a *Bacillus thuringiensis* (*B.t.*) gene which confers resistance to Heliothine pests such as tobacco budworm and cotton bollworm. However, no genetically conferred resistance is presently available for aphids, and these insects continue to be a problem which require more conventional chemical and cultural control measures. Fulfill could effectively be used to control aphid pests in transgenic cotton without impacting beneficial populations, which can in turn assist in regulating populations of other pest species.

Field Efficacy

Fulfill has been widely tested in cotton for the control of cotton aphid by Novartis personnel, and university and contract researchers. Figure 1 presents a summary of test results from trials conducted in the United States from 1990-1997. Fulfill at the proposed use rate of 0.086 lbs ai/A (2.75 oz/A formulated 50WG) provided an average of 85% control (range 65-98%) of the cotton aphid when averaged across 29 different trials. The efficacy of several competitive standards was also summarized, where direct comparisons to Fulfill were available in the trials examined. The efficacy achieved with Fulfill was comparable to several competitive products, including Provado™, Furadan™, and Bidrin™.

Figure 2 illustrates the activity of Fulfill against both adult and immature life stages of the silverleaf whitefly, *Bemisia argentifolii*. In this 1993 trial conducted in Texas, Fulfill applied twice at the rate of 0.172 lbs ai/A (5.5 oz/A formulated 50 WG) provided approximately 70% control of adults, and about 45% control of immature stages. Because of the limited control of whitefly immatures demonstrated by Fulfill, it will not be recommended as a stand-alone product for control of whiteflies in cotton. For that reason, Novartis has been investigating the value of tank-mixing Fulfill with other whitefly-active compounds, especially IGR-type materials which are especially active against whitefly immatures, but have limited activity against adults. Figure 3 details the results of a 1997 study in which tank-mix combinations of Fulfill with either Knack (pyriproxyfen) or fenoxycarb were evaluated. The results indicate that combinations of Fulfill and Knack provide enhanced control of whitefly populations when compared to either product applied alone. A combination of Fulfill and fenoxycarb also provided control greater than that provided by Fulfill alone; however, the trial did not contain a stand alone treatment of fenoxycarb for comparison.

Registration Activities

On October 15, 1997, Novartis Crop Protection submitted a petition to EPA requesting registration of Fulfill as a reduced risk pesticide on several crop groupings, including fruiting vegetables, cucurbit vegetables, tobacco, and potatoes. Petitions for cotton, cole crops, and leafy vegetables are expected to be submitted in the third quarter of 1998.

On November 4, 1997, Fulfill was granted reduced risk status by the EPA. The Reduced Risk Pesticide Initiative establishes an expedited review for applications for pesticide registrations that may reasonably be expected to accomplish one or more of the following: 1) reduce the risks of pesticides to human health, b) reduce the risks of pesticides to non-target organisms, c) reduce the potential for contamination of groundwater, surface water, or other valued environmental resources, and d) broaden the adoption of integrated pest management strategies, or make such strategies more available or more effective. Fulfill meets these criteria based on the following parameters: a) Human Health: Fulfill is not a cholinesterase inhibitor, and

therefore has a low acute toxicity. It is anticipated that that Fulfill will not be a "Restricted Use Pesticide", and will carry the least restrictive signal word of "Caution". The low use rate of Fulfill reduces the potential for worker, dietary, and non-occupational exposure. Fulfill is not a mutagen, teratogen, or neurotoxin. Actual plant residues are non-detectable in most cases at proposed pre-harvest intervals, b) Nontarget Organisms: Fulfill has an extremely favorable ecotox profile, and poses minimal risk to birds, bees, fish, and aquatic invertebrates, c) Potential for contamination of valued resources: Fulfill demonstrates only moderate persistence, and also demonstrates a high affinity for soil binding. During the time that Fulfill is present in the environment, it is tightly bound and not available for movement into undesired areas, and d) IPM Compatibility: Fulfill is considered to have excellent potential for utility in integrated pest management and programs because of its selectivity, low use rate, and unique mode of action.

Summary

Fulfill insecticide represents a unique new tool for the management of aphid and whitefly pests in cotton because of the following features: a) new chemistry, b) new mode of action, c) no known cross-resistance to other classes of chemistry, d) high selectivity, and e) reduced risk status.

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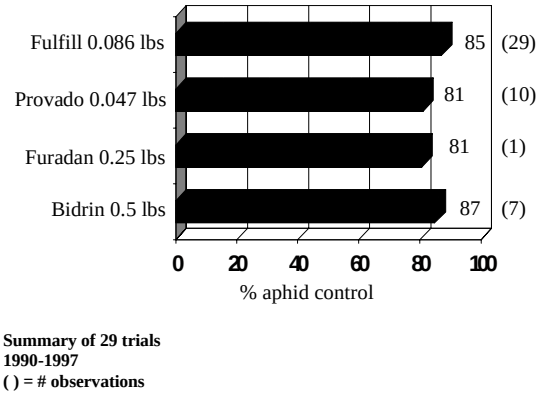

Figure 1. Summary of Fulfill Efficacy on Cotton aphid, 1990-1997. (All rates expressed as lbs ai/A)

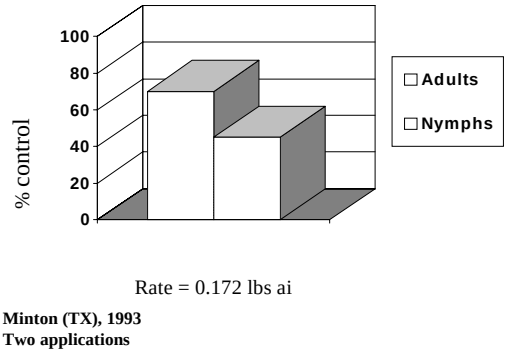

Figure 2. Activity of Fulfill silverleaf whiteflies and adults. (Rate expressed as lbs ai/A)

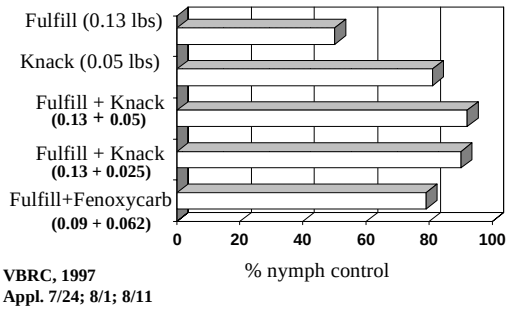

Figure 3. Efficacy of Fulfill tank-mixes against silverleaf whitefly. (All rates expressed as lbs ai/A)