COTTON INSECT MANAGEMENT TOOLS FROM NOVARTIS CROP PROTECTION

Stephen M. White, D. Scott Lawson, John P. Koening and Ngoan Ngo
Novartis Crop Protection, Inc.
Greensboro, NC

Abstract

Novartis Crop Protection has as very broad based product portfolio for the cotton market. The current and future portfolio will include Dual Magnum™, Caparol®, Action® and CGA-362'622 herbicides; a liquid combination of Ridomil Gold™ and Trifoxystrobin fungicide; and Curacron, Denim™, Fulfill™, Actara™, Centric™ and Adage™ insecticides. This paper will focus on the newer insecticide compounds in various phases of development by Novartis Crop Protection. These active ingredients include thaiamethoxam, pymetrozine and emamectin benzoate. These new active ingredients will provide cotton producers with effective management tools which will control thrips, aphids, flea hoppers whiteflies, and foilar and boll feeding lepidoptera. While at the same time all of these active ingredients have unique properties, which results in minimal impact on non-target organisms and important beneficial insects that occur in cotton agro-eco systems. In addition, due to the fact that these compounds have unique activity spectrums, unique chemical and physical properties, as well as novel modes of action they potentially will be important components of resistance management programs in the future. An efficacy overview in cotton for each products is presented and is a synopsis of data presented at this conference over the past few years.

Introduction and Discussion

Thiamethoxam is a second-generation neonicotinoid insecticide being developed for the control of many cotton pests. Thiamethoxam will be formulated to be a seed treatment and as a foliar spray. The commercial name for the seed treatment product is Adage. The Adage seed treatment formulation is highly systemic which moves acropetally into the young seedlings. This systemic movement provides residual insecticidal activity against early season sucking and leaf feeding pests of cotton. The efficacy profile of Adage has been studied by Novartis over the past five years in the cotton production areas of the United States. The results have shown that there is a clear rate response for 50 to 300 g ai/100kg of seed. The three hundred grams per 100 kilo of seed will be the loading rate that will be the labeled rate for Adage. This rate will provide consistent residual control of Tobacco thrips, Cotton aphids and Leafhoppers. Figure 1. shows the residual activity against the Cotton aphid of Adage compared to Temik and Gaucho.

The foliar applied product for cotton will be devloped under two trade names, Centric for mid south cotton and Actara for western cotton. Foliar applications of thiamethoxam provides excellent control of aphids, tarnished plant bugs, whiteflies, thrips, and fleahoppers with very low application rates. Thiamethoxam is highy systemic and has chemical properties which allow it to rapidly penetrate plant tissue to provide a reservoir of active ingredient which is active against leaf feeding pests. Because of this rapid systemic uptake of thiamethoxam which results in a high degree ecological selectivity. Therefore, it is well suited for use in pest management programs that strive to protect and maintain beneficial arthopods. The mode of action of thiamethoxam is presently under investigation. Mode of action studies indicate that thiamethoxam acts by interfering with the nicotinic acetylcholine receptor of the insects nervous system. Thiamethoxam acts through contact and ingestion and results in the cessation of feeding within hours of contact and death results within 24 hours of exposure.

In addition, these unique properties allow thiamethoxam to be applied by both ground equipment and by air and will provide consistent pest control. Field studies conducted over the last several years indicate that pest control with thiamethoxam applied by air or ground is equivalent. (Lawson et. al, 2000 See Poster #73). The anticipated labeled rates of thaimethoxam will be 0.047 – 0.062 lbs ai/A. (Ferguson et al. 1999, Lawson et al., 1999, Parker, 1999). Control of whiteflies with Actara 25WG is excellent (Fig 2). Evaluations of whitefly populations 14 days after the second application of Actara™ 25WG applied at 0.047 lb ai/A indicate superior control of whitefly nymphs compared a registered standard Provado applied at 0.047 lb ai/A.

Control of fleahoppers in cotton with Actara 25WG is superior to the currently registered standard insecticides (Fig 3). Three days after an application, Actara applied at 0.067 lb ai/A was providing numerically better control of fleahoppers compared to the two standard insecticides, Orthene and Provado. When fleahopper densities were evaluated eight days after the application, the population in the untreated check had increased. However, the Actara™ treatment was still providing excellent control.

Pymetrozine has a unique mode of action which is characterized as neural inhibition of feeding. It does not display general toxicant or paralyzing effects on insects; however, it selectively interferes with normal feeding activities by affecting the neural regulation of fluid intake. Also, given the fact Pymetrozine is a highly selective insecticide, very systemic and has a unique mode of action it has been shown to be safe to many beneficial insects. In

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 2:1171-1174 (2000)
National Cotton Council, Memphis TN

1996, Secher demonstrated that Fulfill had wide margins of safety to several predators and parasitoids such as green lacewings, seven-spotted lady beetles, carabid beetles, *Orius spp., Geocoris spp*., syrphid flies, predatory mites and *Encarsia spp.* (Sechser, 1996).

Fulfill is not a rapid knockdown product; however, affected insects stop feeding shortly after exposure. Consequently, mortality due to starvation occurs within 2-5 days. In 1997, Harrewijn is hypothesized that pymetrozine affects the activity of the cibarial muscles, the food pump, and the salivary pump (Harrewijn, 1997). Fulfill has demonstrated excellent activity against several aphid species, including the cotton aphid, *Aphis gossypii.*

Pymetrozine is formulated as Fulfill 50WG and is applied as a foliar spray at a rate of 2.75 oz/A (0.086 lbs ai/A). It is recommended that a penetrating type adjuvant be used with all applications of Fulfill in order to provide good coverage of plant surfaces and to facilitate penetration of the active ingredient into leaf tissue. For optimal control applications of Fulfll should be made to a threshold of less than 50 aphids per leaf and earlier in the season – prior to row closure. If applied under these conditions Fulfill typically exhibits residual activity for a period of about 2 weeks. The cotton Section 3 label for Fulfill is anticipated for spring of this year (2000). For a more in depth overview of Fulfill refer to Koenig et. al 2000, poster #75.

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 (Figure 3.). 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™ (Koenig et al. 1998.) Figure 4.

Emamectin benzoate is a second generation of avermectin insecticide for crop protection being developed by Novartis Crop Protection. It is highly effective against a broad range of lepidopterous pests at very low use rates (8.4- 16.5 g ai/ha). It is most effective when ingested as a neurotoxin, but it also demonstrates contact activity. It's not systemic. However, through translaminar movement, emamectin benzoate penetrates the plant cuticle to form a reservoir of the active ingredient. Emamectin benzoate is highly selective for Lepidopterous larvae and is not disruptive to beneficial arthropods in integrated pest management programs. The compound is being developed in the United States under the trade name Denim™ for cotton. This is the 0.16 emulsifiable concentrate formulation of emamectin benzoate. In 1999 Denim was granted Section 18 exemption in Alabama, Arkansas, Mississippi, Oklahoma and Texas for control of Beet Armyworm, *Spodoptera exigua* and resistant Tobacco Budworm, *Heliothis virescens* (F.).

Results from both laboratory studies and field trials emamectin benzoate has been shown to be one of the most potent insecticides ever developed for control of lepidopterous pests (White et. al 1997). In fact emamectin benzoate has unprecedented potency against a broad spectrum of lepidopterous larvae with LC_{90} values ranging between 0.001-0.02 *ug*/ ml in ingestion-based foliar spray assays. Emamectin benzoate is more potent against tobacco budworm, and beet armyworm than other insecticides, such as fipronil, chlorfenapyr and tebufenozide (Figure 5). In the field, the compound is very effective at controlling many lepidopterous pests at rates between 8.4 and 16.8 g ai/ha. For example, in a field study conducted by Dr. Ron Smith and Mr. Brad Meyer in cotton against Fall Armyworm with several new compounds including Denim (Figure 6). Their results showed that Denim was effective against Fall Armyworm.

Like the pymetrozine and thiamethoxam, emamection benzoate has a unique mode of action. It is theorized that the avermectin class of insecticides bind at multiple sites, including the glutamate and GABA sites, in insect chloride channels. In general, the chloride ion influx produced by the opening of the channel into neuronal cells results in loss of cell function and disruption of nerve impulses. Consequently, after larvae ingest emamectin benzoate the larvae are rapidly paralized and do not feed; subsequently, maximum mortality occurs within two to four days.

Even though, emamectin benzoate is higly toxic to lepidopterous larvae is less toxic to most beneficial arthropods; such as, hymenopterous parasitoids and predatory beetles and bugs. This is especially true when exposure occurs beyond one day after application (Lasota & Dybas 1991).

Resistance Management

Novartis Crop Protection is highly committed to managing the potential development of resistance in arthopod pests. Consequently, Novartis have implement aggressive resistance management projects related to all of our currently registered or insecticides in development. For example, work on establishment of base line toxicity against key pests for thiamethoxam, pymetrozine and emamectin benzoate. In addition, to minimize the development of resistance Novartis insecticide labels are also written to mitigate the potential of developing resistance. Label restriction includes limiting the number applications per season, recommending the rotation to other modes of action, use of the same mode of action against sequential generations is not recommended. For an example of a potential resistance management program with

pymetozine and the neonicotinoid insecticides refer to Koenig et. al 2000 Beltwide Cotton Conference,. Poster #73.

Conclusion

Novartis Crop Protection has a strong commitment to cotton industry in the future. With the new and innovative herbicide, fungicide and insecticide products that will be introduced over the next three years the cotton industry will have access to these new pest management tools that will provide new resources to effectively manage pest problems of today and well into the future. With regard to the insecticides the introduction of Adage, Actara, Centric, Fulfill and Denim, will also contribute significantly in managing pest problems that the cotton grower faces today and in the future. These new Novartis insecticides will provide growers with tools that have unique modes of action, with wide margins of safety to both humans and the environment. The new products provide the growers with new resources to manage a broad spectrum of insect pests that have been historically difficult to control with the older traditional chemistry that may ultimately be phased out.

References

Ferguson, S. F., J. P. Koenig, S. M. White, D. M. Dunbar and D. S. Lawson. 1999. Evaluation of Fulfill® 50WG (Pymetrozine) for cotton aphid control in 1998 field trials. Proceedings of the 1999 Beltwide Cotton Conference, pp. 1016-1019.

Harrewijn, P. and H. Kayser. 1997. Pymetrozine, a Fast-Acting and Selective Inhibitor of Aphid Feeding. In-Situ Studies with Electronic Monitoring of Feeding Behavior. Pesti. Sci. 49:130-140.

Koenig, J.P., D.S. Lawson, S.M. White, and D.M. Dunbar. 1998. Utility of Fulfill 50WG for Aphid and Whitefly Management in Cotton. Proceedings of the 1998 Beltwide Cotton Conference, pp. 997-999.

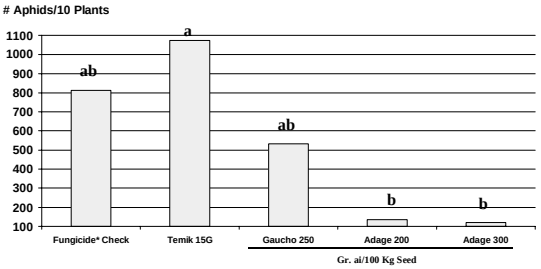
Lawson, D.S, Dunbar, D.M., White, S.M., and Ngo, N. 1999. Actara 25WG: Control of Cotton Pests with a new Neonicotinoid Insecticide, Thiamethoxam. Proceedings of the 1999 Beltwide Cotton Conference, pp. 1106-1109.

Parker, R. D. 1999. New insecticides for control of cotton fleahopper and impact of drought on production. Proceedings of the 1999 Beltwide Cotton Conference, pp. 1055-1056.

Sechser, B. 1996. IPM Fitness and Selectivity (Pymetrozine). Ciba-Geigy AG, Basel, Switzerland.

White, S.M., D.M. Dunbar, R.Brown, B. Cartwright, D. Cox, C. Eckel, R.K. Jannson, P.K. Mookerjee, J.A. Norton, R.F. Peterson, and V.R. Starner. 1997. Emamectin benzoate: A novel avermectin derivative for control of lepidopterous pests in cotton. In, Proceedings Beltwide Cotton Conference, National Cotton Council, Memphis, TN pp. 1078-1082.

Wyss, P. and M. Bolsinger. 1997. Translocation of Pymetrozine in Plants. Pestic. Sci. 50: 195-202.



3.5 Lbs./A

All seeds were treated with Apron XL/Maxim/NuFlow M

Figure 1. Evaluation of Seed Treatments for Early Season Aphid Control on Cotton by R. Parker, Texas (1998).

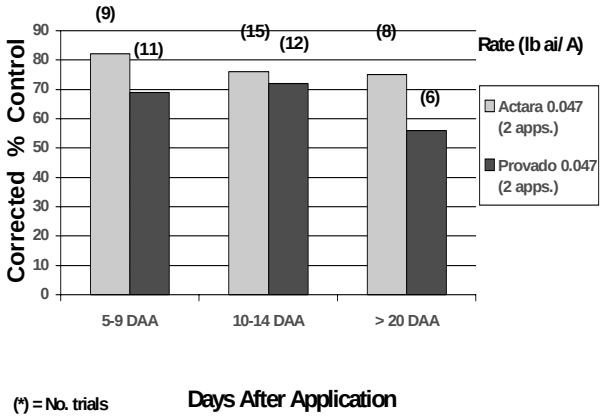


Figure 2. Whitefly control in cotton with Actara 25 WG.

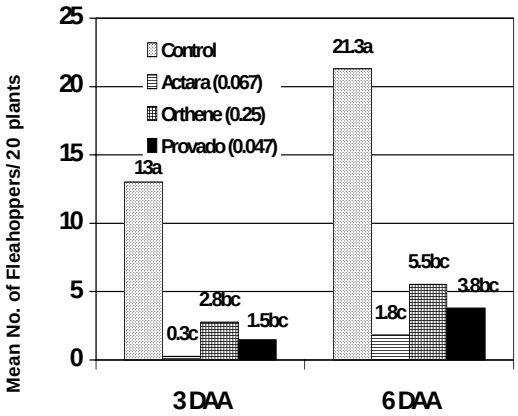


Figure 3. Actara™ 25WG Control of Fleahoppers in Cotton (Dr. Parker, TAES, Corpus Christi, TX).

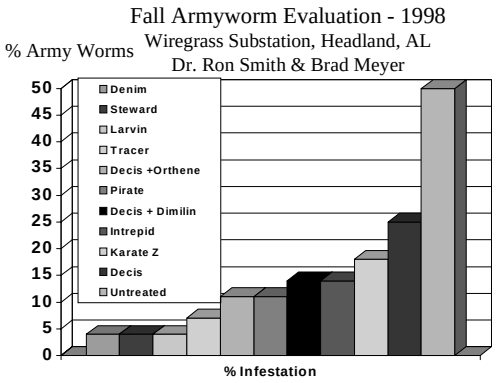


Figure 6. Control of Fall Armyworm on cotton in Alabama, 1998

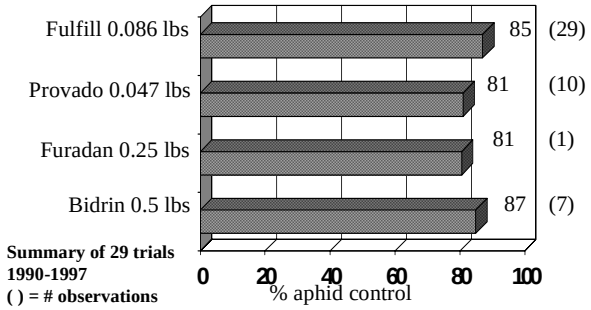


Figure 4. Summary of Fulfill Efficacy on Cotton aphid, 1990-1997. (All rates expressed as lbs ai/A).

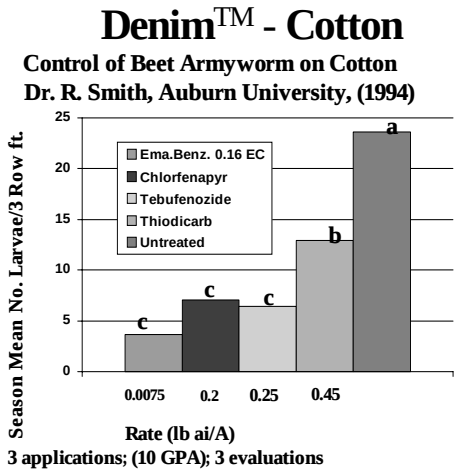


Figure 5. Beet Armyworm control in cotton with Denim.