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TRACER*(spinosad) PERFORMANCE AND RESISTANCE MANAGEMENT UPDATE

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Abstract

Tracer* is a foliar applied insect control product based on the active ingredient spinosad. Spinosad is derived from the aerobic fermentation of the naturally occurring actinomycete *Saccharopolyspora spinosa* and is a member of the naturalyte class of products. In insects, spinosad uniquely alters the function of nicotinic and GABA-gated ion channels in a manner consistent with observed neuronal excitation (agonist). However, spinosad does not interact with known binding sites for other nicotinic or GABAergic insecticides such as neonicotinoids, fiproles, avermectins and cyclodienes. Spinosad has been placed in the IRAC/EPA Mode of Action Category 5 – Nicotinic Acetylcholine Receptor Modulator/Agonist. It is the only compound in this group 5 today, indicating that the mode of action is unique and it can be rotated with all other compounds. Tracer was introduced into the U.S. cotton market in 1997 and it has since been adopted in most cotton growing areas of the world including Australia, Argentina, Brazil, India, Pakistan and West Africa. Tracer was introduced in an era of increased focus on resistance management and, after seven seasons of use, it is appropriate to review how efficacy and resistance management programs are performing.

Tracer demonstrates high levels of activity against most Lepidoptera pests of cotton including tobacco budworm (*Heliothis virescens*), cotton bollworm (*Helicoverpa zea*), beet and fall armyworms (*Spodoptera exigua* and S. *frugiperda*), and soybean loopers (*Pseudoplusia includens*). In the U.S., it is often considered a tobacco budworm compound since it is the best performing foliar applied compound available due to resistance to pyrethroids and older compounds, but the intrinsic activity of Tracer on the other Lepidoptera is as good. Tracer also has good activity on Thysanoptera or thrips. It has essentially no activity on plant bugs or predacious insects, which can provide additional biological control through their conservation. Tracer can be used early, mid or late season but not continuously throughout the season. Earlier use is encouraged to conserve beneficial insects and to save broader spectrum products for later use. Resistance management recommendations request that users refrain from using the product continuously for more than 30 days or 3 consecutive times. If the product has not been used for a window of 30 days (approximately 1 generation of target insects) it may be reused for a maximum of 6 times per season.

Any review of multiple publications on efficacy will illustrate that Tracer continues to perform very well and it is consistently one of the top performers. Tracer is often selected as the standard to compare against when Lepidoptera control is the objective. The oral version of this paper shared some examples from the 2003 Arthropod Management Tests (Entomological Sociiety of America) but many other examples exist. Prior to the introduction of Tracer, baseline data was obtained using the standard Adult Vial Test (AVT). The majority of the baseline work was conducted by Dr. Jerry Graves, LSU retired, during 1991-93 on 19 populations collected in LA and TX. The AVT were first optimized for H. virescens and pyrethroids by Dr. Bill Plapp of Texas A&M and the technique facilitates rapid and robust tests utilizing male moths easily collected from pheromone traps. Spinosad primarily works by ingestion but Dr. Graves demonstrated that there was adequate contact activity to utilize spinosad with the AVT technique. Doses of 5 and 15 micrograms per vial were chosen to represent LC50's and LC95's at 29° C, however the dose response slopes were flatter than with the pyrethroids particularly at lower temperatures and shorter time frames which could lead to false positives if user of the AVT were not careful. The test however was still deemed robust enough to serve as an early warning tool but survivorship at the 15 microgram dose should not necessarily be of concern. Results of AVT tests for 1991 through 2003 were shared and there have been indications of increased tolerance at some locations and during the use season. However, retests of suspect areas have not confirmed the trend suggesting an issue with the test or have indicated any tolerance quickly dissipated.

It is a logical assumption that resistance could develop to Tracer and any other insect control product or trait, particularly with tobacco budworm. The laboratory of Dr. Michael Roe at NCSU demonstrated the potential by selecting a laboratory strain of tobacco budworm for resistance to spinosad. There has been no field selection verified and all investigations of nonperformance have not identified any tolerance issues. Field resistance to spinosad, however, has developed in diamondback moths (*Plutella xylostella*) in Hawaii. In this worst case situation, the population was treated continuously for up to 200 times in a continuous production system. Removal of spinosad from use resulted in tolerance levels quickly falling and spinosad is now being reintroduced for DBM control in Hawaii on a restricted basis using strict rotation schemes. In both of the cases above and in laboratory selected house fly (*Musca domestica*) the resistance was determined to be associated with a single recessive gene that expressed some fitness cost which should help facilitate remedial resistance management efforts if they are ever needed.

After seven years of use there has been no resistance development in cotton pests to Tracer (spinosad). The AVT is a good technique for monitoring for early increases in tolerance; however, the test is not as robust with spinosad at cooler temperatures and shorter time frames as pyrethroids and care should be made in interpreting and confirming the results. The resistance that has been developed to spinosad in the laboratory and in DBM in Hawaii has been recessive and there are fitness costs that appear to aid the dissipation of tolerance. These findings coupled with the increasing number of foliar compounds and insecticidal in-plant traits put Tracer at a low risk to significant resistance concerns in the near future. However, current recommendations should be continued to be adhered to and influencers are advised to continue to be on the alert for the individual grower who might be abusing Tracer or other insect control technologies.

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