IRF-135, AN ALLYL ISOTHIOCYANATE BIOPESTICIDE FOR MANAGING WEEDS, PESTS, AND PATHOGENS IN SOIL.

Gary E. Vallad* and Nathan Boyd, University of Florida, Gulf Coast Research and Education Center, Wimauma, FL 33598

Introduction

Throughout the United States, soil fumigation plays a pivotal role in the management of weed, nematode, and soilborne pathogens in the production of fruiting vegetables, cucurbits, and small fruits. The research described herein is focused on the development of IRF-135 as a broad spectrum soil biopesticide for the control of weed, soilborne pests and pathogens. The active ingredient of IRF-135 consists solely of allyl isothiocyanate (AIT), the same organosulfur compound responsible for the pungency of many brassica species, such as mustard and horseradish. More importantly, AIT is a recognized biopesticide ingredient by the U.S. EPA, making IRF-135 a novel biopesticide-based product for treating soils; and with EPA approval a possible candidate for use in organic production under the USDA National Organic Program. This would be a revolutionary development for organic growers who have few options for the management of many weeds, and soilborne pests and pathogens. For conventional growers, IRF-135 represents a "biopesticide" alternative to methyl bromide and many of the other chemical alternatives (such as chloropicrin, dimethyl disulfide, metam sodium, metam potassium, or 1,3 dichloropropene) that now have stringent label requirements that can include additional air monitoring during and after fumigation, increased personal protective equipment requirements, and increased buffer zones.

Materials and Methods

Two separate sets of trials were established in January and July of 2012 for spring and fall tomato production, respectively, at the University of Florida, Gulf Coast Research and Education Center in Balm, FL to evaluate the efficacy of IRF-135 against weed and soilborne pests and pathogens. Treatments were either applied with a tractor through subsurface knives (3 knives placed 8 inches deep) during bed formation or applied through the drip irrigation (two drip tapes per bed) system following bed formation. Trials were performed on Myakka fine sand with soil temps between 60 - 68 °C and 79 - 85 °C in January and July; final beds were 8 inches tall, 32 inches at the base with 28 inch bed tops. Spring trials assessed IRF-135 applied subsurface during bed preparation at 170, 195, 255, and 340 lb/A versus 1,3-D dichloropropene and chloropicrin (PicChlor 60) at 300 lb/A. Drip applications consisted of IRF-135 at 15, 20, 30, and 40 GPA versus metam potassium (Kpam) at 60 GPA in 0.25 acre-inch injection volumes. All trials included non-treated controls, and were arranged as a randomized complete block design with VIF (1.25 mil) and TIF (2 mil) plastic mulches as the whole block factor, and fumigant treatments in 75 ft sub-plots. Fall trials were similar, but assessed IRF-135 at 170, 213, 255, and 468 lb/A in sub-surface applications and at 20, 25, 30, and 40 GPA in drip applications, and utilized a thinner TIF (1.25 mil) plastic mulch. In each trial, tomato yields, the emergence of purple and yellow nutsedge, the occurrence of nematodes (counts and root gall ratings), and the incidence of diseases caused by soilborne pathogens were collected. Additional soil cores were also drawn from bed centers to assess the recovery of total *Fusarium* spp. on semi-selective media, as a means to measure efficacy against soilborne pathogens.

Results and Discussion

Sub-surface knife applications: In the spring trial, total yields of all IRF-135 treatments were statistically equivalent to the PicChlor 60 standard and higher than the non-treated control (Fig. 1). In the fall trial, total yields from all IRF-135 treatments were statistically equivalent or better than the PicChlor 60 standard, with only the 255 and 468 lb/A rates of IRF-135 resulting in total yields that were statistically better than the non-treated control (Fig. 2). The 195, 255, and 340 lb/A rates of IRF-135 were statistically equivalent to the PicChlor 60 standard in reducing nutsedge emergence by 80% relative to the non-treated control in the spring trial (Fig. 1), while weed pressure was negligible in the fall trial. In the spring trial, all soil treatments reduced the recovery of *Fusarium oxysporum* from 673 CFU/g in non-treated soil to as low as 31 CFU/g in IRF-135 treated soils (Fig. 1). Interestingly, none of the fumigant treatments effectively suppressed a natural outbreak of Fusarium crown rot in the fall trial (Fig. 2). Plastic mulch had no statistical effect on Fusarium crown rot, on the recovery of *Fusarium oxysporum* from soils, or on tomato yields in either trial (Fig. 1 & 2). However, the use of TIF mulch (2 mil) alone drastically reduced nutsedge emergence by 70% compared to the VIF mulch (1.25 mil) in the spring trial.

Drip irrigation applications: In both spring and fall trials, total yields of all IRF-135 treatments were statistically equivalent to the Kpam standard and the non-treated control; although all treatments were numerically higher than the non-treated control (Fig. 1 & 2). Plastic mulch had no effect on total yields in the fall trial. Although, in the spring trial there was a significant treatment by film interaction with total yields for the 40 GPA rate of IRF-135 vastly improved under VIF compared to TIF mulch when compared to the non-treated control (data not shown). In both trials, IRF-135 treatments statistically reduced nutsedge emergence compared to the non-treated control (Fig. 1 & 2). In the spring trial, IRF-135 treatments were equivalent to the Kpam standard in reducing nutsedge emergence; however, Kpam statistically performed better than IRF-135 in the fall trial. The TIF (2 mil) film alone statistically reduced nutsedge emergence by 69% compared to the VIF (1.25 mil) in the spring trial, while the thinner TIF (1.25 mil) film in the fall trial still resulted in a significant 64% reduction in nutsedge emergence. All soil treatments also statistically reduced the recovery of *Fusarium oxysporum* compared to the non-treated control (Fig. 1 & 2), for which film had no effect. In most cases the IRF-135 treatments were equivalent to the Kpam standard (with the exception of the 20 GPA IRF-135 in the fall), but the 40 GPA rate of IRF-135 performed statistically better than Kpam in the spring trial, and numerically better in the fall trial.

In summary, under field conditions with low to moderate weed and soilborne disease and nematode pressure, the performance of IRF-135 was on par with the metam potassium and PicChlor 60 standards. However, drip applications of IRF-135 appeared more effective than sub-surface knife applications against nutsedge and soilborne pathogens as based on the recovery of *Fusarium oxysporum* from treated soils. All soil treatments appeared to benefit from the use of a TIF versus VIF plastic mulch for reducing nutsedge emergence. Results from a third set of treatments will be discussed at the conference. Grower demonstration trials are planned for the Spring of 2014.

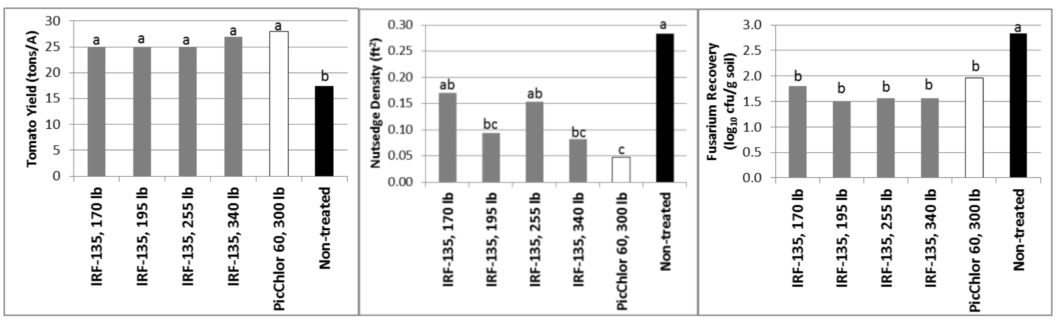

Figure 1. The effect of sub-surface knife applied IRF-135 compared to a PicChlor 60 standard and a non-treated control on total tomato yield, nutsedge density and the recovery of total *Fusarium oxysporum* from plots (left to right), averaged across TIF and VIF plastic mulch treatments in the spring of 2013.

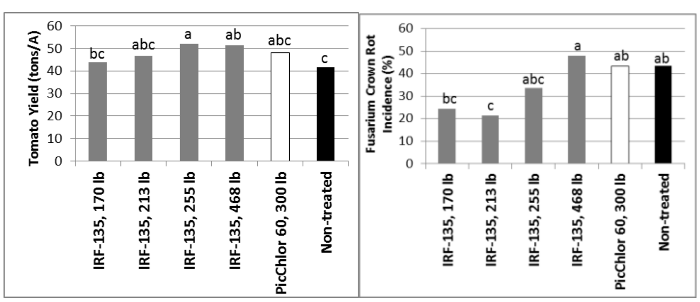

Figure 2. The effect of sub-surface knife applied IRF-135 compared to a PicChlor 60 standard and a non-treated control on total tomato yield and the incidence of Fusarium crown rot (left to right), averaged across TIF and VIF plastic mulch treatments in the fall of 2013.

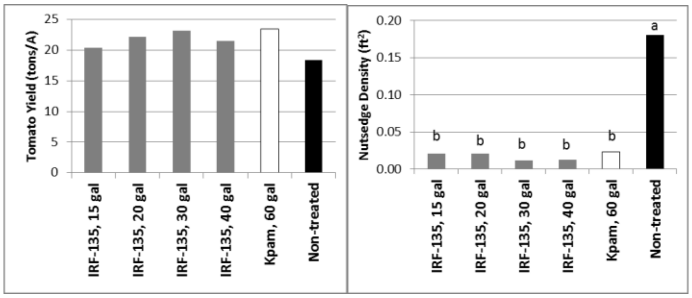

Figure 3. The effect of drip irrigation applied IRF-135 compared to a Sectagon K45 (Kpam, metam potassium) standard and a non-treated control on total tomato yield, nutsedge density and the recovery of total *Fusarium oxysporum* from plots (left to right), averaged across TIF and VIF plastic mulch treatments in the spring of 2013.

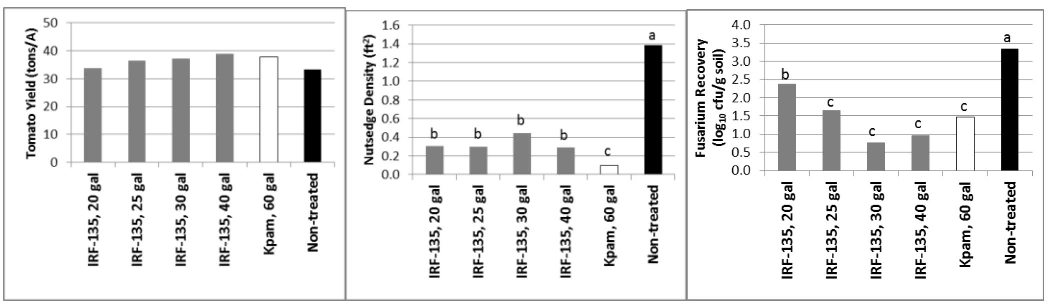

Figure 4. The effect of drip irrigation applied IRF-135 compared to a Sectagon K45 (Kpam, metam potassium) standard and a non-treated control on total tomato yield, nutsedge density and the recovery of total *Fusarium oxysporum* from plots (left to right), averaged across TIF and VIF plastic mulch treatments in the fall of 2013.