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Report

Tarnished Plant Bug Control Technologies: Diversity, Resistance, and Sustainable Management in Mississippi

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Tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois), is the most important insect pest of cotton in Mississippi. Recent research has been conducted to improve sampling procedures and thresholds for this pest (Musser et al. 2007, 2009a, 2009b; Gore et al 2012). Insect control costs associated with foliar insecticide applications targeting tarnished plant bug have reached levels that are no longer sustainable for cotton production in many areas of the Mid-South (Fig. 1). Previous highs for foliar insect control costs averaged $73.56 from 1992 to 1995 (Williams 1993-1996). These highs correlate with the occurrence of tobacco budworm, *Heliothis virescens* (F.), outbreaks due to widespread resistance to pyrethroid insecticides (Elzen et al. 1992) (Fig. 1A). Fortunately, the first transgenic Bt cotton varieties were released for commercial use in 1996 (Fig. 1B). The Bt technologies have continued to provide absolute control of tobacco budworm and have virtually eliminated that insect as a pest in many areas. Another important event in the recent history of cotton insect management was the initiation of the boll weevil, *Anthonomus grandis grandis* (Bohemon), eradication program in the falls of 1998 (south Delta) and 1999 (north Delta) (http://www.cotton.org/tech/pest/bollweevil/index.cfm). The initial stages of that program relied on multiple applications of malathion, an organophosphate insecticide, and all cotton acres in the Delta were sprayed multiple times per year beginning in 2000 (Fig. 1C). The applications were made as ultra-low volume (ULV) sprays in vegetable oil, a practice that increases the acute and residual control of insect pests (Scott and Lloyd 1975). Consequently, the first cases of organophosphate resistance by tarnished plant bug in Mississippi were documented in 2004 (Snodgrass et al. 2009), a mere four years after the first widespread applications of ULV malathion (Fig. 1D). The relationship is not clear, but it appears that applications with malathion for boll weevil eradication provided the initial selection pressure for tarnished plant bug resistance to the organophosphates (Snodgrass and Scott 2003). Regardless of the initial cause of organophosphate resistance in tarnished plant bug, control costs associated with this insect have become unsustainable. To achieve acceptable levels of control, growers generally have to make multiple applications with tank mixes of organophosphates and pyrethroids at their highest labeled rates. In addition to the direct increase in cost of control, those applications usually flare secondary pests, such as cotton aphid, *Aphis gossypii* Glover, and twospotted spider mite, *Tetranychus urticae* (Koch). As a result, additional applications are often needed for those pests resulting in higher input costs.

A sustainable management plan is needed for tarnished plant bug in the Mid-South. Currently, growers in the Delta regions are spending an average of $130 to $150 per acre for foliar insect control (Williams

2012-2014). This is in addition to technology fees associated with transgenic varieties and seed treatments for early season insect management. Prior to transgenic cotton, promoting earliness in the crop through variety selection and planting date was an important component of tobacco budworm management (Luttrell 1994). Research has shown that significant benefits can also be observed where tarnished plant bug is the primary pest (Adams et al. 2013). Similar experiments are currently being conducted with leaf pubescence and irrigation that suggest similar results. Additionally, area-wide management strategies have shown benefits for tarnished plant bug management (Snodgrass et al. 2005, 2006). Some of these approaches have been adopted by growers, but the benefits of these approaches have not been sufficient to make cotton production sustainable in the current economy. Initially, novel insecticides were thought to be a solution to the current problem with tarnished plant bug. However, sulfoxaflor (Transform WG™, Dow AgroSciences) was labeled in 2013, but only provided marginal benefits for tarnished plant bug management.

Over the last 5 years, input costs associated with cotton production have surpassed the input costs that growers experienced from pyrethroid resistant tobacco budworm in the mid-1990's. During that time, transgenic cotton was released and restored the sustainability of cotton production in many areas (Greenplate 1999). Unfortunately, no such technology exists for tarnished plant bug. Biotechnology companies are most likely developing transgenic technologies to manage this important pest. However, they are probably still very early in the discovery phase, and it will be several years before a technology similar to Bollgard cotton will be introduced for tarnished plant bug management. In the meantime, growers and pest managers will need to incorporate all of the tools currently available to manage this pest. Despite the use of those tools, cotton production will not be sustainable in many areas of the Mid-South until a transgenic event is developed and released for commercial use.

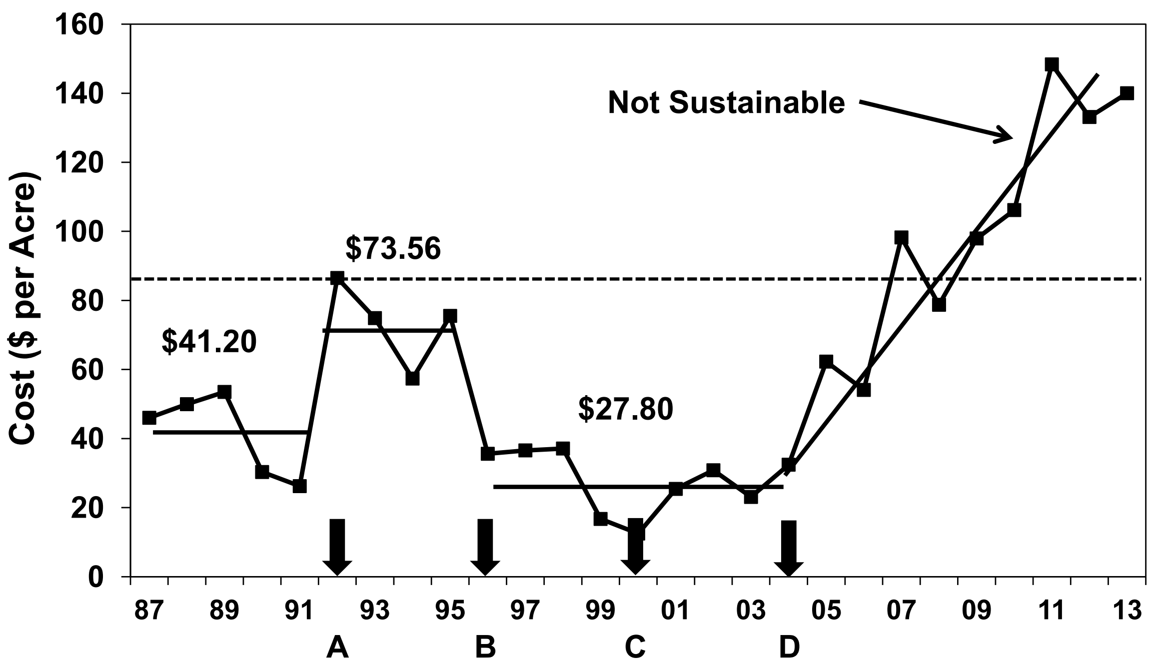

Figure 1. Average foliar insect control costs for cotton in the Mississippi Delta from 1987 to 2013 (Williams 1988-2014). Arrows along the X-axis correspond to important events that influenced insect control over this time period (A = widespread resistance to pyrethroids in tobacco budworm, B = introduction of Bollgard® cotton, C = first season with all areas of the Delta in boll weevil eradication, D = documented resistance to organophosphates in tarnished plant bug).

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