EFFECTS OF DEFOLIANTS ALONE AND IN COMBINATION WITH INSECTICIDES ON BOLL WEEVIL AND WHITEFLY IN COTTON: F. ECONOMIC CONSIDERATIONS

J. R. C. Robinson
Assoc. Professor & Extension Economist
Texas A&M Research and Extension Center
Weslaco, TX
S. M. Greenberg and T. W. Sappington
Integrated Farming and Natural Resources Research Unit
Kika de la Garza Subtropical Research Center, USDA-ARS
Weslaco, TX
A. N. Sparks, Jr. and J. W. Norman, Jr.
Texas A&M Research and Extension Center
Weslaco, TX

Abstract

The paper reviews the various findings in the economics literature on the efficiency of cotton defoliation strategies. The discussion then focuses on the potential cost savings of adding sub-lethal insecticides with routine defoliant sprays in the Texas Lower Rio Grande Valley. The evaluation of economic benefits is complicated by time/space dimensions, but the small marginal cost of diapause insecticides may justify including them in defoliation sprays, provided that such treatments are uniformly applied to a large area. The latter condition is necessary to enable physical, technological substitution of in-season weevil sprays for cheaper diapause sprays.

Introduction

Cotton defoliation is an accepted technology across the U.S. Cotton Belt. The benefits of defoliation include earliness, improved lint grade, and in some cases improved yield. Avoiding harvest-season weather risk is an underlying aspect of these benefits. Another possible benefit of defoliation is reduced harvest costs from greater efficiency of equipment.

Economic evaluations of alternative cotton defoliation treatments show results that differ across regions. A fairly comprehensive economic evaluation in the Delta States showed no effects of harvest aid chemicals on lint grade and value. This study showed mixed effects on yield and net returns among various harvest aid treatments (Larson et al., 1998). These differences varied across regions where treatments including the boll opener Prep significantly improved yields and net returns, but only in the more northern parts of the study area. Larson et al. (1998) concluded that the benefits of harvest aids in the southern study area likely involved cost savings from increased harvest efficiency.

Defoliation trials in South Texas illustrate a different trade-off between defoliation and the timeliness of ginning. Brashears et al. (1998) showed no significant improvements in lint grade or yield from additional harvest aid treatments when cotton modules were ginned immediately. On the other hand, when cotton modules were stored for 24 days, their research showed an average marginal benefit of 1.85 cents per pound in response to an additional harvest aid treatment. For a 700 pound yield, the 1.85 cent difference would be worth $13 per acre, which matches the marginal cost of an additional harvest aid spraying.

This paper examines the economics of combined defoliation/pest control decisions. These decisions highlight trade-offs between diapause weevil sprays and next year's in-season weevil sprays. Defoliants may influence pest populations indirectly by affecting the host crop as well as by direct toxicity or synergy with other insecticides (Liu et al., 2001; Greenberg et al., 2001). The pest management implications of defoliant/insecticide combinations are more difficult to evaluate because they have multi-year/area/crop dimensions. The following sections discuss these issues within the context of a typical cotton production system in the Texas Lower Rio Grande Valley (LRGV).

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Cotton Costs of Production

Irrigated LRGV cotton is characteristically input intensive and high-cost. Texas Extension Service planning budgets show approximately $75 per acre in machinery-related costs which are fixed in the short run (i.e., farmers face these expenses whether they produce a crop or not). The bulk of production costs are the so-called variable costs of inputs over which the producer has differing degrees of discretion. For example, about 27% of typical variable costs are made up of harvesting and ginning and are a simple function of yield (Figure 1). Another large portion of variable inputs like fuel and labor are mostly a function of land preparation and tillage systems which are relatively fixed in the short. Growers therefore have the most discretion and control over the remaining direct cash inputs comprised largely of chemicals.

The cost structure and distribution in Figure 1 reflects cotton under low weevil pressure, i.e., four in-season weevil sprays per acre plus one worm treatment. Diapause weevil sprays are not used much, if at all, by LRGV farmers. For comparison purposes, Figure 2 shows the relative share of expenses under conditions of high weevil pressure, reflected by an additional $33 per acre in in-season weevil sprays. This added expense increases the share of insecticide from 11% to 19% of total variable costs. These expense breakdowns highlight the long-term goals of this research project. Figuratively speaking, a gain in economic efficiency is shown by shrinking the total variable cost "pie" in Figure 2 to one such as in Figure 1. The issue then becomes the possibility of substituting more expensive in-season weevil sprays for cheaper diapause/defoliant treatments.

Experimental Evaluation

Detailed information on the cotton field and experimental design has been described by Greenberg et al. (2001). An examination of specific treatment costs in Table 1 shows a very low marginal cost of adding low-rate diapause weevil insecticides with the defoliant application. The typical defoliant treatment using full rates of either Dropp 50WP or DEF 6 costs between $10 and $12 per acre, in addition to $2 to $3 per acre for application. Single defoliation treatments account for about 4% to 5% of total variable costs (Figure 1, 2). Adding the full rate of Karate or half rate of Guthion represents a marginal cost increase (this year) of about $3.80 per acre. Any positive economic impact on this year's harvest costs, whitefly control (also this year, but on other crops), or next year's boll weevil pressure/costs will be measured against this small $3.80 per acre marginal cost.

It is easiest to picture the economic trade-offs in terms of diapause sprays vs. in-season sprays. Spending an extra $3 per acre at defoliation to reduce one $10 per acre in-season boll weevil spraying next year is an obvious benefit. The cost saving is clear since the diapause insecticide rate is half and the application cost is zero (i.e., the material is applied with defoliation. In Figure 3 this trade-off is shown by an isocost line with a slope of -3.33 between zero and one level of diapause spraying. Beyond this level, additional diapause spraying is assumed to cost $5 per acre due to separate application costs. This is reflected by a kink in the isocost line with a slope of -2 above the kink. The iso-cost lines show the possibilities of substitution in purchasing, i.e., trading off the expense of one input for the other, while holding total insecticide cost constant for each iso-cost line.

Besides cost, the other determinant of input substitution involves the production or technical substitution possibilities. In Figure 3., the curve

CAB represents is the locus of input combinations that maintain a given level of production. This "isoquant" curve is drawn almost L-shaped to reflect the hypothesis of limited substitution possibilities. For example, the combinations of input levels between Point A to Point C along the isoquant do not reflect lower levels of in-season spraying because of the steepness of the slope. Likewise, moving between Points A and B only implies a fractional change in diapause spraying for a one unit change in in-season spraying. The reason for this because of the lack of area-wide effect, resulting in re-infestation by overwintered weevils from other cotton fields in the area.

For comparison, consider the trade-off possibilities between diapause and in-season sprays that are available within an area-wide boll weevil eradication (BWE) program. BWE program managers can (and do in their program budgeting) make decisions about how many diapause sprays vs. how many in-season sprays across a large area. Thus we would expect the locus of available input combinations within BWE to be convex, but less L-shaped than in Figure 3.

The optimal combination of diapause and in-season treatments is that joint level where the rates of substitution in purchasing and production are equal. These rates of substitution are reflected as the slopes of the isocost and isoquant curves in Figure 3. Thus the optimal combination Figure 3 is at Point A which is the point of tangency between the isoquant and the isocost curves. Point B represents an inefficient point of tangency with a higher in-season spray level and higher isocost line.

The potential of this project is to achieve a small re-allocation of spraying and lowing of costs. The rates of input substitution in both purchasing and in production will probably not allow for greater than one diapause spray being substituted for an in-season spray. Greater substitution possibilities would have to come through lowering the cost of diapause treatments and/or increasing diapause treatment efficacy through uniform, area-wide adoption.

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Table 1. Treatment Costs For Field Testing of Defoliant/Insecticide Combinations (Weslaco, TX, 2000).

	AVERAGE PRICES	
DEF 6	$5.54	per pt
Dropp 50W	$54.87	per lb
Guthion 2L	$3.84	per pt
Karate 2.08	$2.03	per oz
	TREATMENT COSTS	
DEF 6 @ 2 pt/acre	$11.08	per acre
Dropp 50W @ 0.2 lb/acre	$10.97	per acre
Karate 2.08Z @ 1.85 oz/acre	$3.76	per acre
Guthion 2L @ 1 pt/acre	$3.84	per acre
DEF (2 pt) + Karate (1.82 oz)/acre	$14.83	per acre
DEF (2 pt) + Guthion (1 pt/acre)	$14.92	per acre
Untreated Check	$0.00	per acre

**Treatment costs do not include group application costs of ca. $2*/acre.

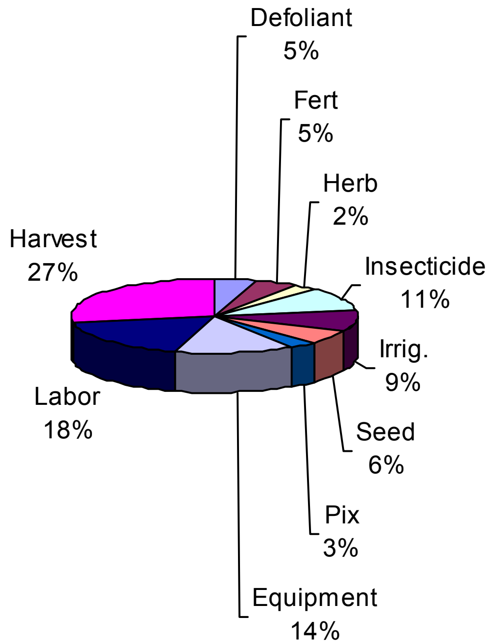

Figure 1. Specified Input Shares for Total Variable Cost of $299/Acre (Low Weevil Pressure).

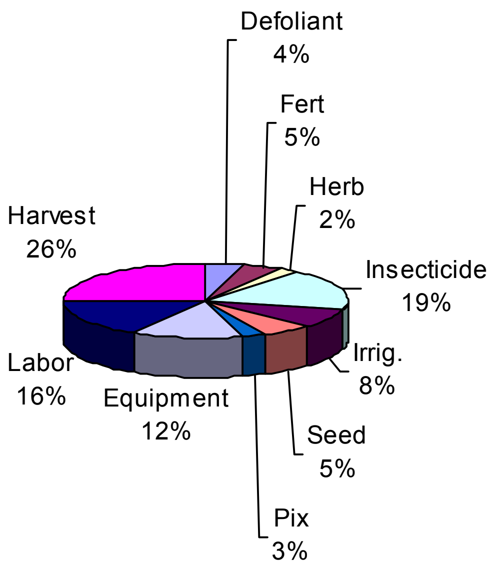

Figure 2. Specified Input Shares for Total Variable Cost of $326/Acre (High Weevil Pressure).

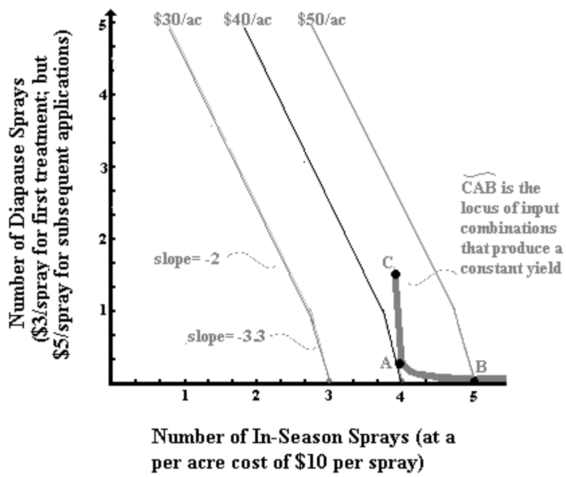

Figure 3. Graphical Depiction of Hypothesized Substitution Possibilities and More Efficient Allocation (from B to A).