# EARLIER COTTON HARVEST AND INCREASED YIELD WITH DIMILIN® (DIFLUBENZURON)

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## Abstract

The use of Dimilin for controlling cotton insects has been associated with enhancing maturity and increasing yields. A review of results between 1979 and 1982 indicated blocks treated with Dimilin were ready for harvest 11 days earlier and yielded 85 lbs. lint/acre more than the grower's standard insecticide program, when multiple applications of Dimilin were made for boll weevil (*Anthonomus grandis*). Preemptive applications of Dimilin for beet armyworm (*Spodoptera exigua*) or fall armyworm (*Spodoptera frugiperda*) control at 5 sites in 1997 resulted in an increase of 73 lbs. lint/acre. At one site, where potential differences in crop maturity were documented, cotton treated with Dimilin matured 14 days earlier. Possible explanations for these observations will be discussed.

## Introduction

Earliness in a cotton crop is obtaining an acceptable yield potential in the shortest time from planting (Munro, 1971). It is an advantage because it allows harvest under more favorable conditions with minimal field loss. Improved fiber quality is also associated with earliness.

One of the plant breeder's goals is early maturing varieties. As early as 1910, Leake noted that the lower the main stem node at which the first fruiting branch is initiated, the earlier the cotton matures. Loss of first squares/bolls from introduced *Lygus lineolaris* and *Helicoverpa zea* has been shown to decrease yield and delay maturity (Holman and Oosterhuis, 1995).

Similarly, time to "cutout" is positively associated with earliness. Boll load has been shown to influence fruiting behavior and is the primary controlling factor of cutout (Paterson et al., 1978). The use of starter fertilizer and fungicide at planting can reduce the time to cutout in early planted cotton (Stevens et al., 1995).

Laboratory tests by Moore and Taft (1975) demonstrated with boll weevils (*Anthonomus grandis*) that egg hatch was prevented or larval development was adversely affected when $P_1$ adults ingested or came in contact with TH-6040 (Dimilin). Up to 99% control of weevils was through tarsal contract with Dimilin suspended in oil and applied to cotton plants (Ganyard et al., 1977). Haynes (1992) also found Dimilin to be an effective synergist for malathion when adult weevils were exposed by means of tarsal contact.

A poster presentation by Shadbolt (1983) documented that 4 to 6 weekly applications of Dimilin for boll weevil in 1979, at a rate of 0.062 lbs. a.i./acre, resulted in earlier maturing cotton with greater yield compared to fields receiving standard insecticide treatments. First application of Dimilin was made when the cotton crop was at the 'pinhead' square stage of development. Subsequently other insecticides were needed to control other insects and were applied at threshold levels, as determined by scouting. The average increase in lint yield in plots treated with Dimilin was 123 lbs./acre; 106 of 112 sites exhibited an increase. Also, 89 of 112 plots treated with Dimilin matured 10 days earlier, on average, than plots treated with standard insecticides. Coincident with the earlier field maturity a greater proportion of the cotton was harvested at first picking. The author noted that early use of Dimilin helped maintain levels of beneficial insects and helped protect early bolls, resulting in earlier cotton maturity. Dimilin is noted for its minimal effect on beneficial insects (e.g. Ables et al., 1977; Ruberson et al., 1993).

The main objective of this paper is to evaluate Dimilin for early season control of cotton boll weevil in the years 1975 to 1996, and to analyze results for yield and time to harvest as available. In addition, results from trials conducted after 1996, where Dimilin was used as a preemptive treatment for controlling beet armyworms (*Spodoptera exigua*) or fall armyworms (*Spodoptera frugiperda*), will be discussed with regard to insect control, and effects on yield and maturity.

## Materials and Methods

Trials discussed in this paper were large plot experiments conducted by contract and grower cooperators. Cotton was grown using typical commercial practices throughout the Cotton Belt. Insect populations and/or damage ratings were determined by standard procedures. Specifics concerning methods of application are identified in the **Results** section.

## Results

### 1975-1996

A series of large scale tests was established to investigate the effect of early season use of Dimilin for control of boll weevil on cotton. A minimum of 3 applications of Dimilin at 0.062 lbs. a.i./acre were made at weekly intervals. Dimilin was applied with 32 or 64 oz./acre of emulsifiable vegetable or paraffinic crop oil as a tank-mix. Oil improves penetration of Dimilin into adult weevils, and eggs subsequently laid are affected at hatching (Ganyard et al., 1977). Initial applications were made at the pinhead square stage. Treatment for other insect pests was initiated when their populations reached threshold levels; all pests in the paired grower's standard insecticide control program were

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treated once threshold populations were attained. Seventy-six sites across 8 states and 11 years were identified.

Growers' standard treatments were grouped across 12 yield categories and plotted against percent increase in cotton lint yield for treatments with Dimilin (Figure 1). Dimilin increased lint yield approximately 15% in most of the groups of 200 to 1300 lbs./acre. Although the response to Dimilin was greater than 70% at sites yielding less than 200 lbs./acre, they were considered outliers. These and any year with less than 5 sites were omitted from further analyses to give a more balanced data set.

The response in lint yield to application of Dimilin is illustrated in Figure 2 for the years 1979 to 1982. There was a significant response for these years, ranging from an increase of 145 lbs./acre in 1979 to 60 lbs./acre in 1981. It was generally considered droughty in 1981. The average yield increase with Dimilin for the 65 sites was 85 lbs./acre.

Additionally, the response to Dimilin for these 65 sites was grouped by state across years (Figure 3). A significant response was determined for states, ranging from an increase of approximately 160 lbs./acre in Louisiana to about 5 lbs./acre in Georgia. Coincidentally, 14 of the 16 entries from Georgia were from the droughty year, 1981.

Eleven of the sites reported a differential maturity for blocks treated with Dimilin compared with those treated with the growers' standard programs. Harvest was approximately 11 days earlier in plots sprayed with Dimilin (95.0% confidence interval for mean = ± 4 days; $\underline{p}$ = 0.0002). Fifteen sites also reported percent first pick and there was a 7% increase in first pick in the treatments with Dimilin (95.0% confidence interval for mean = ± 6%; $\underline{p}$ = 0.03).

**Yazoo City, MS (Site 1), 1997**

A large paired block (≥20 acres) experiment was established on Bt cotton. The grower standard insect control program consisted of 6 applications of either carbamate, organophosphate, or pyrethroid from 9 June to 15 August for control of boll weevils, plant bugs, cotton bollworm and beet armyworms. Dimilin at 0.031 lbs. a.i./acre was included as a tank-mix with the grower's standard in the last 5 applications and applied to the adjacent block. One less application for plant bugs was required in the block with Dimilin. The insecticide plus application cost for the grower standard and that for Dimilin were $48.99 and $57.26, respectively, and lint yields were 1119 and 1227 lbs. lint/acre, respectively, which gave a net gain of $56/acre for the block treated with Dimilin. The block with Dimilin was noticeably earlier in maturity, however days advancement in maturity was not recorded.

**Yazoo City, MS (Site 2), 1997**

Another large paired block (≥20 acres) experiment was established on Bt cotton. The grower standard program for insect control consisted of 10 applications of carbamate, organophosphate, or pyrethroid from 10 June to 9 September for control of boll weevils, plant bugs and cotton bollworm. Dimilin was included in the grower standard program during the 5 August application at the first sign of beet armyworm egg masses. An adjacent block had Dimilin (0.031 lbs./acre) tank-mixed with the grower standard for 5 applications between 16 June and 22 August. There were 4 less boll weevil applications needed in the block with Dimilin and scouting revealed no signs of beet armyworm egg masses. The cost of insecticide plus application cost for the grower standard and that for Dimilin was $72.61 and $59.07, respectively. Respective lint yields of 970 and 1043 lbs./acre calculated to a net gain of $43.80/acre in the block treated with Dimilin. The block with Dimilin was noticeably earlier in maturity, however days advancement in maturity was not recorded at this site.

**Camilla, Georgia, 1997**

A 25-acre Bt cotton block was given 3 applications of Dimilin at 0.062 lbs. a.i./acre between 20 July and 21 August. The grower standard insect program in an adjacent 25-acre block consisted of pyrethroid applications on 11 and 21 August for fall armyworms. Percent plants with fall armyworms on 11 August and 21 August were 15 and 16% for Dimilin, and 56 and 33% for the grower standard program. Dimilin cost $21.56/acre and the pyrethroids totaled $15.06/acre. The grower standard program and that for Dimilin respectively yielded 1305 and 1358 lbs. lint/acre, resulting in a net gain of $27.95/acre when Dimilin was used.

**Statesboro, Georgia, 1997**

Five applications of Dimilin at 0.031 lbs. a.i./acre were supplemented into the grower standard insecticide program on conventional cotton from 15 July to August 25. There were 4 replications of the 2 treatments, with each block occupying 10 acres. The standard program consisted of 5 pyrethroid treatments and 1 pyrrole treatment for fall armyworms, cotton bollworms and tobacco budworms (*Helicoverpa virescens*). Threshold levels of budworms/bollworms indicated the need for an additional pyrethroid application on 9 August in the block with Dimilin. The last pyrethroid application was made on 12 September. On both 17 and 21 August, fall armyworms levels were 80% less in the blocks with Dimilin. The program with Dimilin cost $18/acre more. The grower standard program and that for Dimilin respectively yielded 2651 and 3118 lbs. seed cotton/acre, resulting in a net gain of $88 with Dimilin over the standard program. It was observed that plants treated additionally with Dimilin had a heavier bottom boll load, were shorter, had less boll rot, and were ready for harvest 14 days earlier than those in the grower standard program.

**Vidalia, Louisiana, 1997**

A large paired block (40 acres per block) experiment was established on Bt cotton. The grower standard insecticide

program consisted of 8 applications of either carbamate or organophospate between 10 June and 29 July for boll weevil control. The Dimilin block had 0.031 lbs. a.i./acre tank-mixed at each of the above applications. No beet armyworms were observed in either block during the insecticide application period. A mixture of pyrethroid and organophosphate was applied to the entire test on 1 August for plant bugs. Scouting showed that the plant bug population was 58% lower in the block sprayed with Dimilin. The program with Dimilin cost $25/acre more. The grower's standard program and that for Dimilin yielded 922 and 890 lbs. lint/acre, respectively, resulting in a net loss of approximately $45/acre with Dimilin at this site. It was noted by the contract cooperator that the block for Dimilin contained more "sandy" areas and thus the yield potential was considered lower for this treatment.

## Discussion

The cotton plant typically produces 60% of its blooms during the first 3 weeks of flowering, and these produce approximately 85% of the final yielding bolls. Those blooms which will naturally abort range from about 5 to 60% during those first 3 weeks. Since 90% or more of the squares shed prior to bloom are caused by insect damage (e.g. Mauney and Henneberry, 1984), the need for early square and boll protection is crucial.

The review of results with Dimilin from 1975 to 1996 for controlling boll weevil indicated this program significantly increased lint yields approximately 15% if the grower standard program yielded at least 200 lbs. lint/acre (Figure 1). The data set for the years 1979-1982 indicated an average yield increase of 85 lbs. lint/acre with Dimilin (Figure 2), which compares with 123 lbs. lint/acre increase with Dimilin presented by Shadbolt (1983) for 1979. It is likely that the twelve 1979 sites summarized here are part of the 112 sites discussed by Shadbolt (1983). Shadbolt mentioned that the severity of Heliothine infestations was usually less where Dimilin was used. He stated the early use of Dimilin would have minimal effect on beneficial insects and would protect early bolls, resulting in earlier maturity and providing a net benefit to the grower.

Although Dimilin is not registered for Heliothine control, an egg laid on residue of Dimilin on the cotton plant may inhibit the developing neonate from hatching. It is unlikely that Dimilin would control hatched larvae since they are square/boll feeders on cotton, areas where little Dimilin would be available for ingestion. Dimilin is not translocated from one plant part to another. Field activity with Dimilin at rates for boll weevil control on low infestations of the Heliothine complex has been published (e.g. Hopkins, et al., 1984; Graves et al., 1992). The observations of some activity of Dimilin on plant bugs at Yazoo City (Site 1), Mississippi and at Vidalia, Louisiana warrant additional research.

The presence of Dimilin may be affecting various insects at sub-threshold levels and thus positively affecting final yields. Dimilin appears, in some instances, to predispose insects so that they are more susceptible to other insecticides when tank-mixed. Dimilin is also known to be synergistic with Bt cotton (Weiland et al., 1997) and with several cotton insecticides (Van Laeke and Degheele, 1991; Haynes, 1992; Haynes, 1995).

One to two applications of Dimilin are effective in controlling beet armyworms as long as infestations are not at levels were no insecticide would perform (Weiland et al., 1996). The use of multiple low dose applications of Dimilin starting around pinhead square has been shown to reduce beet armyworm numbers (Lambert, 1992) and to minimize foliar damage by beet armyworms and soybean loopers (*Pseudoplusia includens*) with increased lint yield (Burris et al., 1994). Results presented here (Camilla and Statesboro, Georgia) additionally demonstrate that multiple early applications of Dimilin to developing bolls/bracts and foliage is an effective measure in lessening the resultant damage by fall armyworms. Yield increases were documented at both locations.

Weiland (1997) recently showed that an application of Dimilin to indeterminate soybeans in the absence of significant infestations of insect pests resulted in a 12% increase in seed yield over untreated plants. Soybeans which responded were in the early through mid-pod growth period. It now appears that the application of Dimilin results in increased pod numbers and thus increased seed number (Weiland, unpublished). A similar response with cotton is being investigated.

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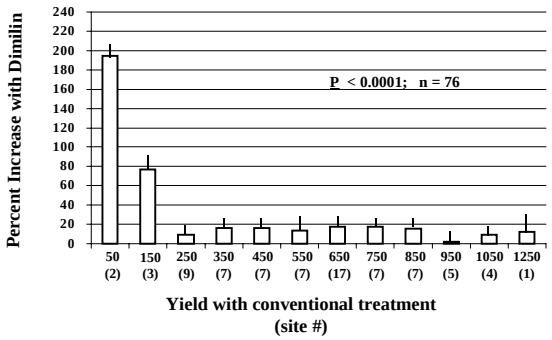


Figure 1. Percent increase in yield with Dimilin compared to yield (lbs. lint/acre) with conventional insect treatments from 1975 to 1996, with 95% LSD interval.

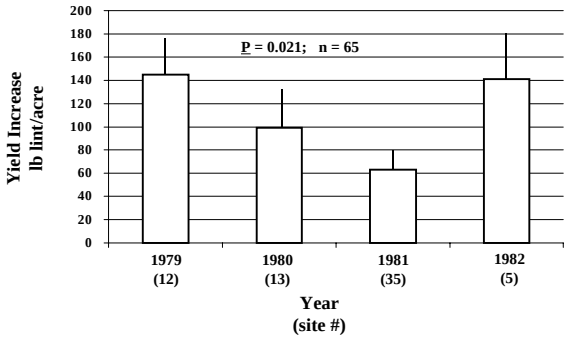


Figure 2. Increase in cotton lint yield with treatment of Dimilin versus yield with conventional insect treatment for the years 1979 to 1982, pooled across states, with 95% LSD interval.

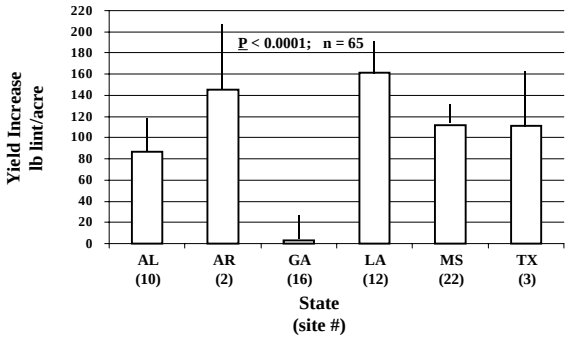


Figure 3. Increase in cotton lint yield with treatment of Dimilin versus yield with conventional insect treatment by state, pooled across the years 1979 to 1982, with 95% LSD interval.