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# IMPACT OF HONEY BEES ON BT COTTON PRODUCTION

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## Abstract

The widespread use of transgenic Bt cotton varieties in the southeastern U.S has allowed many farmers to dramatically reduce applications of broad-spectrum insecticides. As a result, insect pollinators, including honey bees, are returning to cotton fields. This 2-year study investigates the relationship between cotton production and proximity of supplemental honey bee sources, using two irrigated Bt cotton fields. During year 1, both per boll cotton yield indicators and honey bee foraging activity declined with increasing distance from bee sources that were placed in adjacent corners of the bee field. No such trends were observed between yield indicators or bee activity and distance from field corners in the non-bee field. Similar trends were found during year 2 of the study, when status of the fields (bee or non-bee) was reversed. These results suggest a significant positive impact of supplemental honey bees on cotton yield.

## Introduction

Upland cotton (*Gossypium hirsutum* L.) is self-fertile; the pollen needed to fertilize seeds and produce a mature boll can come from the flower producing the boll. However, cotton breeders have long recognized that self-pollinated blossoms usually don't produce quite as many seeds or as much lint as cross-pollinated flowers (Stephens1956). Several investigators have demonstrated increased yields in cotton that was artificially cross-pollinated (e.g., Rose and Hughes 1955, Kohel 1968). Cross-pollination of cotton is achieved almost exclusively by insects, cotton pollen being too heavy for effective wind pollination. Several scientists have cited benefits derived by cotton from insect pollination. Shishikin (1946, 1952) demonstrated that saturation pollination in areas at the rate of 1/2 colony of honey bees per acre increased cotton production by 19.5% over areas depending only upon natural pollinators. Radoev and Bozhinov (1961) obtained an 11-24% greater yield from cotton flowers freely visited by bees compared with flowers tied to exclude insects; there were more seeds per boll, fewer motes and improved seed germination. Tanda (1984) found bee pollination to increase yield in two interplanted varieties of Asian cotton (*Gossypium arboreum* L.).

In spite of several studies indicating the potential benefits of pollinators to cotton production, there has been relatively little interest in this subject in recent years, at least in the U.S. This is probably due to the decimation of pollinator populations near and within cotton fields as a result of the heavy use of synthetic organic insecticides since the 1950s. However, boll weevil eradication and the use of transgenic Bt-cotton varieties are dramatically reducing insecticide use on cotton over much of the southeastern U.S. It may now be possible to establish and/or maintain populations of pollinators, especially honey bees, in many cotton-producing areas that are large enough to significantly improve cotton production. This could benefit cotton producers and beekeepers alike; cotton is an excellent source of nectar for honey production and, in some areas, is an important late-season nectar source when other sources are scarce.

We present here the results of a two-year field study designed to assess the effects of supplemental honey bees on production in irrigated Bt-cotton fields.

## Materials and Methods

### Study Area, Pollinator Sources

The study area was located in Madison County, Alabama, at Tate Farms, approximately eight miles north of Huntsville. The study was conducted in two fields (Field 1= 140 acres; Field 2= 150 acres) 1.5 miles apart, which have been used exclusively for irrigated cotton production for the past 10 years; both fields have center-pivot irrigation systems. The Alabama Beekeepers Association provided the honey bee colonies used in this study.

### Study Design and Data Collection

The study was initiated July 16, 1999, when all honeybee hives had been set up and cotton had started flowering. One hundred forty colonies (1 colony per acre) of honey bees were divided between the NW and NE corners of the bee field outside the irrigated area. A transect sampling line was initiated at each corner containing bees, running diagonally away from each group of hives to the opposite corner of the field. Fifteen sampling points were established at intervals (100, 200 and 400 feet apart, 15 sampling points per transect) along each transect line at increasing distances from honey bee colonies.

A similar set-up was used for the non-bee field, except that no bees were placed in the field corners where transects were initiated. Twenty 1-2 day-old flowers were tagged at each sampling point in both fields for four consecutive weeks, approximately one week after initiation of flowering. Observations of honey bee foraging activity were also made during the 4 weeks of flower tagging, between 10:00 a.m. and 12:00 noon. Bee activity at selected sampling points was measured by counting the number of bees foraging within a 40-ft radius of the sampling point stake for 3 minutes. All boll samples from tagged flowers were collected just prior to harvest (post-defoliation). Number of bolls per 80-tagged flowers was determined for all samples, followed by ginning and determination of lint and seed weights. The study was repeated in summer, 2000, using the same two fields, except that bees were placed in the field used as the non-bee field in 1999.

**Data Analysis**

Simple linear regression analysis was used to determine the relationship between (1) cotton yield indicators (boll weights and boll numbers) and the distance from bee sources or field corners and (2) bee activity levels and the distance from bee sources or field corners .If bees are affecting yield, yield indicators should decline with increasing distance from bee sources, assuming that bee activity in the cotton field also declines with increasing distance from bee sources. There should be no such trend in the fields where no bees were placed.

## Results

**Cotton Production and Proximity of Bee Source**

Regression analysis indicates a significant negative relationship between cotton yield indicators and distance from bee source in bee fields. Per boll (lint + seed) weights for tagged flower samples (weeks pooled) declined with increasing distance from bee sources during both years of the study; this negative trend was significant for year 1 ($0.01<p<0.05$), but not year 2 ($0.15<p<0.20$; Fig. 1). In contrast, there were no trends detected between cotton yield indicators and distance from field corners in non-bee fields during either year of the study ($p>0.20$; Fig. 1). This suggests that the effect seen in bee fields was not related to proximity to field edges. There was no consistent relationship between boll number (boll retention) and distance from bee sources.

**Bee Activity and Proximity of Bee Source**

As expected, bee activity was significantly greater in bee fields than in non-bee fields ($p<0.05$). Additionally, bee activity in bee fields showed a significant declining trend with increasing distance from bee sources ($p<0.05$; data pooled for weeks and years; Fig. 2). Bee activity levels in bee fields declined to levels roughly similar to those of non-bee fields 1500- 2000 ft from bee sources. We did not find any trends between bee activity and distance from field corners in non-bee fields; nevertheless there was significant honey bee activity observed in non-bee fields (Fig. 2).

## Conclusions

1. This study suggests a positive impact of supplemental honey bees on cotton yield indicators in Bt cotton, as indicated by decreasing per boll weights with increasing distance from bee sources. Trends were consistent over both years of the study, as bees were switched from one study field to the other. No such trends were detectable in non-bee fields during either year of the study.

2. Bee activity patterns were consistent with those of yield indicators, significantly decreasing with increasing distance from bee sources, with no trends in non-bee fields. These results were also consistent over both years of the study.

3. Our ability to detect an apparent honeybee impact on cotton yield in such a small study suggests the need for additional larger studies designed to quantify such an effect.

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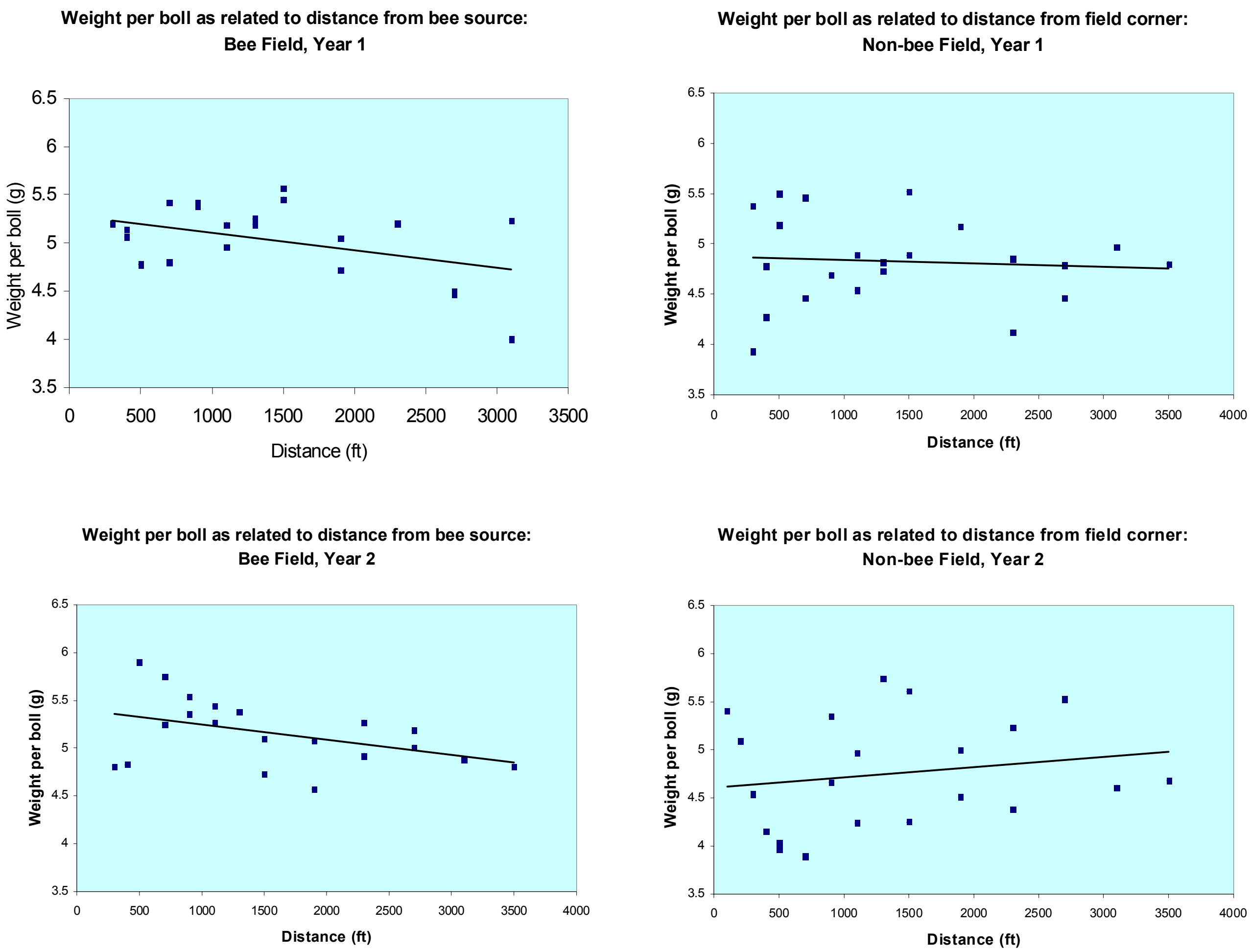
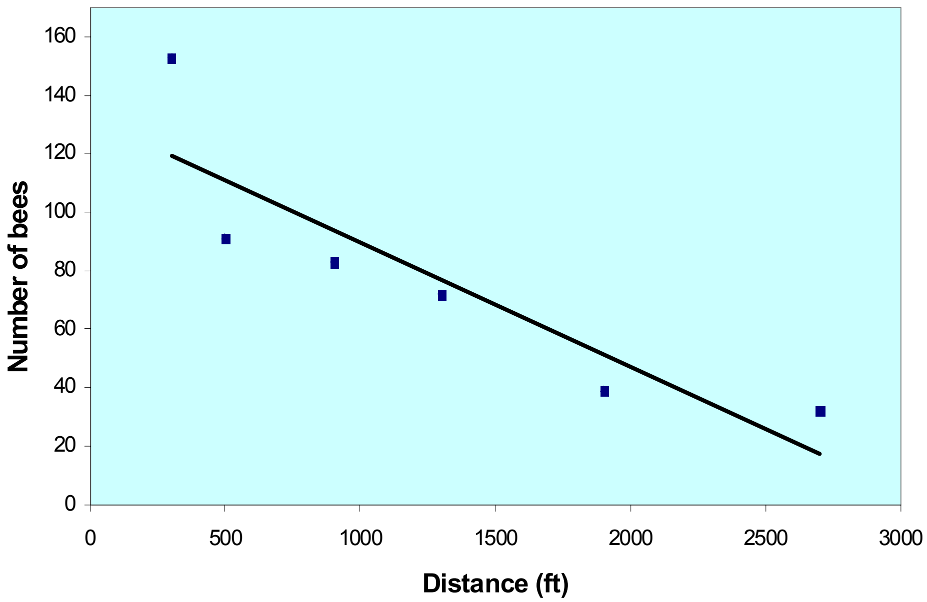



Figure 1. Cotton per boll weights for tagged flower samples (weeks pooled) in relation to distance from bee sources/field corners.

**Bee activity as related to distance from bee source:**
**Bee Field, Years combined.**




**Bee activity as related to distance from field corners:**
**Non-bee Field, Years combined**

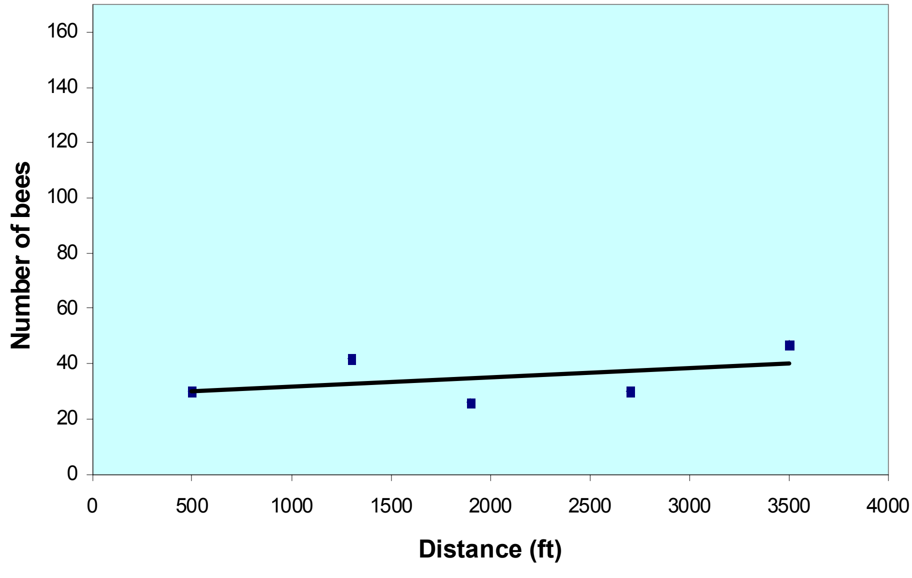



Figure 2. Bee activity (weekly samples pooled) as related to distance from bee sources/field corners.