Tarnished Plant Bug
Sampling Methods and Thresholds

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Existing Situation

• With use of RR cotton, some growers are adding an insecticide to Roundup applications before bloom even when TPB are below threshold
• With use of Bollgard cotton, many sprays after first bloom are targeted for TPB
• Most scouts use a plant count, but there is no standard whole plant sampling procedure
• Mid-season TPB thresholds need to be re-examined
• General lack of confidence in TPB thresholds after first bloom
Objectives

• Identify **efficient** and **accurate** TPB sampling methods in mid-season cotton
• Verify or adjust current TPB thresholds
• Standardize recommended scouting procedures and thresholds in the mid-south
2005 Methods

- 120 commercial fields in TN, MS, LA, AR
- 4 sites in each field
- 5 direct sampling methods (# bugs, time)
- 4 indirect sampling methods (damage, time)
2005 Sampling Efficiency

- Direct Sampling methods
  - Sweep net is most efficient for adults
  - Drop cloth most efficient for nymphs
  - Sweep net and drop cloth about equal for total bug efficiency

- Indirect sampling methods
  - Dirty blooms most efficient
2006 Sampling Methods

• 60 commercial fields in TN, MS, LA, AR
• 4 sites in each field
• 3X per day (6-9 AM, 11 AM-2 PM, 4-7 PM)
• Three direct sampling methods (# bugs, time)
  – Sweep net (25 sweeps)
  – Drop cloth (5 row ft.)
  – Modified whole plant (25 plants)
    • Terminal, 2 squares, 1 bloom, 1 boll
2006 Methods

- Four indirect sampling methods (damage, time)
  - Damaged squares (25 squares)
  - Dirty blooms (25 blooms)
  - Internal boll damage (25 bolls)
  - External boll damaged (25 bolls)
Average Number of Plant Bugs Found per Sample

Direct Sampling Counts

- **Drop Cloth /5 row ft.**
- **Sweep Net /25 sweeps**
- **Whole Plant /25 plants**

<table>
<thead>
<tr>
<th></th>
<th>Nymphs</th>
<th>Adults</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>AR</td>
<td>3</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>LA</td>
<td>4</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>MS</td>
<td>5</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>TN</td>
<td>6</td>
<td>5</td>
<td>11</td>
</tr>
</tbody>
</table>
Average % Damage Found per Sample

State and Sampling method

Dirty Squares
Dirty Blooms
External Bolls
Internal Bolls
Average Time for One Sample

The chart above illustrates the average time taken for each sampling method. The vertical axis represents the minutes per sample unit, while the horizontal axis lists the different sampling methods: Drop, Sweep, WholePlt, Squares, Bloom, ExtBolls, and IntBolls. The bar heights show the time taken for each method, with 'WholePlt' and 'IntBolls' requiring the most time, nearing 7 minutes per sample unit, while 'Drop' and 'Sweep' require the least, around 1 minute per sample unit.
Average Number of Bugs Found Per Minute

<table>
<thead>
<tr>
<th>Sampling Method</th>
<th>Nymphs</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drop Cloth</td>
<td>2.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Sweep Net</td>
<td>1.6</td>
<td>0.4</td>
</tr>
<tr>
<td>Whole Plant</td>
<td>0.2</td>
<td>0.2</td>
</tr>
</tbody>
</table>
Average Damaged Fruit Observed Per Minute

<table>
<thead>
<tr>
<th>Sampling Method</th>
<th>Damage /min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dirty Squares</td>
<td>4</td>
</tr>
<tr>
<td>Dirty Blooms</td>
<td>9</td>
</tr>
<tr>
<td>External Bolls</td>
<td>5</td>
</tr>
<tr>
<td>Internal Bolls</td>
<td>1</td>
</tr>
</tbody>
</table>
Correlations of sampling methods

- Created a PB score based on all 7 sampling methods (PB score = 1 at threshold)
- Correlated each sampling method to the composite score
## Correlation of sampling methods to each other

<table>
<thead>
<tr>
<th>Method</th>
<th>2005</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drop Cloth</td>
<td>0.855</td>
<td>0.540</td>
</tr>
<tr>
<td>Sweep Net</td>
<td>0.900</td>
<td>0.582</td>
</tr>
<tr>
<td>Whole plant</td>
<td>0.926</td>
<td>0.649</td>
</tr>
<tr>
<td>Dirty Squares</td>
<td>0.869</td>
<td>0.705</td>
</tr>
<tr>
<td>Dirty Blooms</td>
<td>0.783</td>
<td>0.651</td>
</tr>
<tr>
<td>External Bolls</td>
<td>0.780</td>
<td>0.511</td>
</tr>
<tr>
<td>Internal Bolls</td>
<td>0.661</td>
<td>0.533</td>
</tr>
</tbody>
</table>
## Correlations with Yield

<table>
<thead>
<tr>
<th>Method</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweep Net (Adults)</td>
<td>-0.313</td>
</tr>
<tr>
<td>Sweep Net (Nymphs)</td>
<td>-0.41</td>
</tr>
<tr>
<td>Drop Cloth (Adults)</td>
<td>-0.334</td>
</tr>
<tr>
<td>Drop Cloth (Nymphs)</td>
<td>-0.262</td>
</tr>
<tr>
<td>TPB per 25 sweeps</td>
<td>-0.4</td>
</tr>
<tr>
<td>Drop Cloth</td>
<td>-0.31</td>
</tr>
<tr>
<td>% Square Retention</td>
<td>0.587</td>
</tr>
<tr>
<td>Nymphs per 25 squares</td>
<td>-0.432</td>
</tr>
<tr>
<td>% Dirty Squares</td>
<td>-0.638</td>
</tr>
<tr>
<td>% Internal Square Damage</td>
<td>-0.489</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Method</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Boll Damage (Small)</td>
<td>-0.365</td>
</tr>
<tr>
<td>%Boll Damage (Medium)</td>
<td>-0.475</td>
</tr>
<tr>
<td>%Boll Damage (Large)</td>
<td>-0.404</td>
</tr>
<tr>
<td>%Boll Damage (Total)</td>
<td>-0.452</td>
</tr>
<tr>
<td>Dirty Blooms per row ft.</td>
<td>-0.303</td>
</tr>
<tr>
<td>% Dirty Blooms</td>
<td>-0.357</td>
</tr>
<tr>
<td>Shed Squares</td>
<td>0.031</td>
</tr>
<tr>
<td>Shed Bolls</td>
<td>-0.057</td>
</tr>
</tbody>
</table>

J. Gore
# Factors Altering Bias

<table>
<thead>
<tr>
<th>Factor</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind</td>
<td>↓ PB with ↑ wind using whole plant sampling, but no impact with sweep net or drop cloth</td>
</tr>
<tr>
<td>Plant height</td>
<td>↓ PB on taller plants using whole plant and drop cloths, but not sweep net</td>
</tr>
</tbody>
</table>
## Black vs. White Drop Cloth

<table>
<thead>
<tr>
<th>TPB Stage</th>
<th>White</th>
<th>Black</th>
<th>% difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults</td>
<td>1.17a</td>
<td>0.98a</td>
<td>-16</td>
</tr>
<tr>
<td>Nymphs</td>
<td>7.43a</td>
<td>9.55b</td>
<td>+29</td>
</tr>
<tr>
<td>Total</td>
<td>8.60a</td>
<td>10.53b</td>
<td>+22</td>
</tr>
</tbody>
</table>
Sampling Methods Summary

• Overall
  – Sampler variability is great in all sampling methods
  – No method appears to be more or less sensitive to sampler variability

• Direct Sampling methods
  – Sweep net is most efficient for adults
  – Drop cloth most efficient for nymphs, esp. black drop cloth
  – Sweep net and drop cloth about equal for total bug efficiency
  – Counts by all methods decrease during the hottest part of the day (3-6 PM)
  – Sweep nets catch fewer when foliage is wet

• Indirect sampling methods
  – Dirty blooms most efficient
  – Dirty squares have best correlation to other methods
TPB Thresholds - Early Season

Trial Treatments

- **Auto**: Automatic insecticide application at pinhead square and 7 and 14 days later
- **Low**: Threshold of 8 PB / 100 sweeps or square retention below 80%
- **High**: Threshold of 16 PB / 100 sweeps or square retention below 60%
- **UTC**: No insecticide prior to first bloom

All applications made with Centric at 2 oz/ac
MS Early Season TPB Threshold Trial

Weekly Automatic
6 per 100
None

TPB per 100 sweeps

0 1 2 3 4 5 6 7 8

6/7 6/15 6/21 6/26 7/5 7/12
MS Early Season TPB
Threshold Trial

<table>
<thead>
<tr>
<th>Date</th>
<th>Auto</th>
<th>8/100</th>
<th>16/100</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>6/21/2006</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6/26/2006</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7/5/2006</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Square Retention
MS Early Season TPB
Threshold Trial

Early Season TPB Thresholds

- Automatic PH, 7, 14
- 3 weeks after 1st square
- Untreated

Yield
- # of Sprays

Number of Sprays
- 0
- 0.5
- 1
- 1.5
- 2
- 2.5
- 3
- 3.5

Lint (lb/acre)
- 0
- 200
- 400
- 600
- 800
- 1000
- 1200
- 1400
- 1600
TPB Thresholds- Mid Season

Trial Treatments

– **Auto**: Insecticide application every 7 days from first bloom to cutout
– **Low**: Threshold of 1 PB / 5 row ft.
– **Med**: Threshold of 3 PB / 5 row ft.
– **High**: Threshold of 5 PB / 5 row ft.
– **VHigh**: Threshold of 10 PB / 5 row ft.

All applications made using an organophosphate insecticide (acephate, Bidrin)
MS Mid-Season TPB Thresholds-2006

Drop Cloth Thresholds

Yield and Number of Sprays

<table>
<thead>
<tr>
<th>Condition</th>
<th>Lint (lb/acre)</th>
<th># of Sprays</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automatic</td>
<td>1,2,3,4,5,6</td>
<td>ab</td>
</tr>
<tr>
<td>Low-1/5ft</td>
<td>1,2,3,5,6</td>
<td>a</td>
</tr>
<tr>
<td>Med-3/5ft</td>
<td>1,3,6</td>
<td>ab</td>
</tr>
<tr>
<td>High-5/5ft</td>
<td>2,4,5</td>
<td>b</td>
</tr>
<tr>
<td>Very High 10/5ft</td>
<td>2,4,5</td>
<td>b</td>
</tr>
</tbody>
</table>
TPB Thresholds-2005

Yield
No. Applications

Pounds (seedcotton per plot)

5% Dirty Squares
10% Dirty Squares
20% Dirty Squares
Drop Cloth Squares
Squares
Whole Plant
UTC

Yield:
1, 3, & 4
1, 2, & 4

No. Applications:
1, 2, & 4
1, 3, & 4
5% Dirty Squares
10% Dirty Squares
20% Dirty Squares
Drop Cloth Squares
Squares
Whole Plant
UTC

Number

0
1
2
3
4
5
6

Pounds (seedcotton per plot)
Mid-Season TPB Thresholds, 2006

Lint (lb/acre)

Thresholds

Number of Sprays

Check 5% Dirty Sq 10% Dirty Sq 20% Dirty Sq Drop 3/6ft Mod Whole 15% 15 bug/100 Sq Sweep 20/100

Lint (lb/acre):
- Check: c
- 5% Dirty Sq: ab
- 10% Dirty Sq: ab
- 20% Dirty Sq: b
- Drop 3/6ft: ab
- Mod Whole 15%: ab
- 15 bug/100 Sq: ab
- Sweep 20/100: a

Number of Sprays:
TPB Thresholds-2006

Yield

No. Applications

<table>
<thead>
<tr>
<th></th>
<th>Pounds (lint per acre)</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>5% Dirty Squares</td>
<td>2, 3, 4 &amp; 5</td>
<td></td>
</tr>
<tr>
<td>10% Dirty Squares</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>20% Dirty Squares</td>
<td>1 &amp; 4</td>
<td></td>
</tr>
<tr>
<td>Drop Cloth 3/6 rowft</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>15 bug / 100 sq</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>15 TPB/100 plants</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>UTC</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

TPB Thresholds-2006 (Pounds (lint per acre))

Graph showing various thresholds and their corresponding yield and number of applications.
TPB Thresholds-2005

Sweep Net Threshold

Don Cook
TPB Thresholds-2006

Sweep Net Threshold

lb Seed cotton/acre

<table>
<thead>
<tr>
<th>5%</th>
<th>10%</th>
<th>15%</th>
<th>20%</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Don Cook
Conclusions

• Early-Season
  – No benefit from automatic applications
    • Risk flaring other insect pests

• Mid-Season
  – Sweep net and whole plant thresholds are too high compared to drop cloth
    • 12 TPB/ 100 sweeps ≈ 9 TPB/ 100 plants ≈ 3 TPB / 6 row ft
  – Threshold of 10% dirty squares, 1 TPB/2 row ft on a drop cloth or 10 TPB/100 sweeps looks to be optimal
Acknowledgements

• Funding: Cotton Incorporated
• Data contributions:
  – Jeff Gore, USDA-ARS
  – Don Cook, LSU AgCenter
• Cooperation
  – Extension agents, consultants and cotton growers who facilitated these trials and data collection in commercial fields