Influence of Timing and Degree of Weed Management on Crop Yield and Contribution to Weed Emergence the Following Year
Introduction

• Timing of weed control generally influences yield (Everman et al. 2008; Knezevic et al. 2003; Tursun et al. 2016)

• Weed management costs for agronomic crops can vary considerably (Jordan et al. 2014)

• Most weed management trials focus only on a single crop without documenting impacts on subsequent seasons

• Few experiments include multiple crops in a manner allowing direct statistical comparisons
Objectives

• To determine the number and timing of herbicide applications needed to optimize weed control, yield, and estimated economic returns in corn, cotton, grain sorghum, and soybean

• To compare the effect of crop or herbicide program during the previous year on contributions to the seedbank
Materials and Methods

• Locations: Lewiston-Woodville (Norfolk sandy loam) and Rocky Mount (Aycock very fine sandy loam)
  - Common ragweed and Texas millet (Lewiston-Woodville)
  - Palmer amaranth and large crabgrass (Rocky Mount)

• Year 1
  - Corn, cotton, grain sorghum, and soybean planted early May
  - Experimental design: split-plot with summer crop serving as the whole plot unit and timing of herbicide application serving as the sub-plot unit
  - Plot size: 4 rows (91-cm spacing) by 9 m
  - Management other than weed control of all crops was based on North Carolina Extension Service recommendations
Materials and Methods

- Herbicide application timings
  - 2 weeks after planting (WAP) only
  - 6 WAP only
  - 2 and 4 WAP
  - 4 and 6 WAP
  - 2, 4, and 6 WAP
  - Non-treated control
<table>
<thead>
<tr>
<th>Herbicides</th>
<th>Lewiston-Woodville</th>
<th>Rocky Mount</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WAP</strong></td>
<td><strong>2</strong></td>
<td><strong>4</strong></td>
</tr>
<tr>
<td>Corn</td>
<td>glyphosate</td>
<td>glyphosate</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cotton</td>
<td>glyphosate</td>
<td>glyphosate</td>
</tr>
<tr>
<td>Grain sorghum</td>
<td>quinclorac</td>
<td>bentazon</td>
</tr>
<tr>
<td>Soybean</td>
<td>glyphosate</td>
<td>glyphosate</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>glyphosate + dicamba</td>
<td>glyphosate</td>
</tr>
<tr>
<td>Cotton</td>
<td>glyphosate + dicamba</td>
<td>glyphosate + dicamba</td>
</tr>
<tr>
<td>Grain sorghum</td>
<td>quinclorac</td>
<td>bentazon</td>
</tr>
<tr>
<td>Soybean</td>
<td>glyphosate + dicamba</td>
<td>glyphosate + dicamba</td>
</tr>
</tbody>
</table>
Materials and Methods

• Application Equipment:
  □ CO₂- pressurized backpack sprayer calibrated to deliver 140 L / ha at 125 kPa

• Data collection
  □ Visual ratings of percent broadleaf and annual grass control 7, 10, and 20 WAP
  □ Yield (converted to percent of maximum)
  □ Estimated Economic Returns

• Weed control, percent maximum yield, and estimated economic returns were subjected to ANOVA using PROC GLIMMIX and means were separated using Fisher’s Protected LSD at p ≤ 0.05

• Factorial arrangement of 4 (Crop) × 6 (Herbicide Application Timing)

• Pearson Correlation Coefficients were constructed
# Materials and Methods

<table>
<thead>
<tr>
<th>Crop</th>
<th>Average Price</th>
<th>Base Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$ / kg</td>
<td>$ / ha</td>
</tr>
<tr>
<td>Corn</td>
<td>0.21 ($5.33/bu)</td>
<td>805 ($326/ac)</td>
</tr>
<tr>
<td>Cotton lint</td>
<td>1.60 ($0.72/lb)</td>
<td>1,224 ($496/ac)</td>
</tr>
<tr>
<td>Cottonseed</td>
<td>0.20 ($0.09/lb)</td>
<td>-</td>
</tr>
<tr>
<td>Grain sorghum</td>
<td>0.17 ($3.86/bu)</td>
<td>613 ($248/ac)</td>
</tr>
<tr>
<td>Soybean</td>
<td>0.42 ($11.43/bu)</td>
<td>589 ($239/ac)</td>
</tr>
</tbody>
</table>

*Prices are from 10 year USDA-NASS data (2008-2017)*
Materials and Methods

• **Year 2**
  - Cotton planted into previous season’s plots
  - Herbicide program included POST applications of glyphosate and/or glyphosate plus dicamba at 3 and 7 WAP

• **Data collection**
  - Weed population densities recorded 3, 7, and 20 WAP
  - Cotton lint yield

• Data for weed population densities and cotton lint yield were subjected to ANOVA using PROC GLIMMIX and separated using Fisher’s Protected LSD at $p \leq 0.05$

• The factorial arrangement of treatments during the previous year was considered
Lewiston-Woodville
Year 1

2016
Common ragweed: 129 plants / m²
Texas millet: 75 plants / m²

2017
Common ragweed: 29 plants / m²
Texas millet: 16 plants / m²
### Analysis of variance (P > F) for common ragweed and Texas millet control 10 WAP, percent maximum yield, and estimated economic returns at Lewiston-Woodville.

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>Common ragweed control (10 WAP)</th>
<th>Texas millet control (10 WAP)</th>
<th>Percent maximum yield (%)</th>
<th>Estimated economic returns ($ / ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>13.3*</td>
<td>4.0*</td>
<td>0.4</td>
<td>39.3*</td>
</tr>
<tr>
<td>Crop</td>
<td>9.5*</td>
<td>16.0*</td>
<td>36.2*</td>
<td>347.8*</td>
</tr>
<tr>
<td>Herbicide Application Timing</td>
<td>328.0*</td>
<td>25.4*</td>
<td>169.2*</td>
<td>135.5*</td>
</tr>
<tr>
<td>Year × Crop</td>
<td>4.6*</td>
<td>9.5*</td>
<td>3.1*</td>
<td>37.0*</td>
</tr>
<tr>
<td>Year × HAT</td>
<td>13.7*</td>
<td>1.5</td>
<td>6.9*</td>
<td>11.4*</td>
</tr>
<tr>
<td>Crop × HAT</td>
<td><strong>22.3</strong>*</td>
<td><strong>8.9</strong>*</td>
<td><strong>28.4</strong>*</td>
<td><strong>30.5</strong>*</td>
</tr>
<tr>
<td>Year × Crop × HAT</td>
<td>3.1*</td>
<td>1.2</td>
<td>2.1*</td>
<td>2.3*</td>
</tr>
</tbody>
</table>

* indicates significance at p ≤ 0.05.
Common Ragweed Control 10 WAP

Data are pooled over years at Lewiston-Woodville

Percent

Crop

Corn  Cotton  Grain sorghum  Soybean

NTC  2  6  2 & 4  4 & 6  2, 4, & 6

Legend
Common Ragweed Control 10 WAP
Data are pooled over years at Lewiston-Woodville
Texas Millet Control 10 WAP

Data are pooled over years at Lewiston-Woodville

Crop

<table>
<thead>
<tr>
<th>Crop</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>ghi</td>
</tr>
<tr>
<td>Cotton</td>
<td>k ij</td>
</tr>
<tr>
<td>Grain sorghum</td>
<td>b-h d-h e-i f-i</td>
</tr>
<tr>
<td>Soybean</td>
<td>a-e a-f a-d abc</td>
</tr>
</tbody>
</table>

Legend:
- NTC
- 2
- 6
- 2 & 4
- 4 & 6
- 2, 4, & 6
Texas Millet Control 10 WAP
Data are pooled over years at Lewiston-Woodville

Crop
- Corn
- Cotton
- Grain sorghum
- Soybean

Legend:
- NTC
- 2
- 6
- 2 & 4
- 4 & 6
- 2, 4, & 6
Percent Maximum Yield

Data are pooled over years at Lewiston-Woodville

Crop

- Corn
- Cotton
- Grain sorghum
- Soybean

Legend:
- NTC
- 2
- 6
- 2 & 4
- 4 & 6
- 2, 4, & 6

Percent
Percent Maximum Yield
Data are pooled over years at Lewiston-Woodville
Estimated Economic Returns
Data are pooled over years at Lewiston-Woodville

Crop
- NTC
- 2
- 6
- 2 & 4
- 4 & 6
- 2, 4, & 6
Rocky Mount
Year 1

2016
Palmer amaranth: 54 plants / m²
Large crabgrass: 51 plants / m²

2017
Palmer amaranth: 65 plants / m²
Large crabgrass: 89 plants / m²
Analysis of variance (P > F) for Palmer amaranth and large crabgrass control 10 WAP, percent maximum yield, and estimated economic returns at Rocky Mount.

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>Palmer amaranth control (10 WAP)</th>
<th>Large crabgrass control (10 WAP)</th>
<th>Percent maximum yield (%)</th>
<th>Estimated economic returns ($ / ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>3.1</td>
<td>72.0*</td>
<td>3.5</td>
<td>24.3*</td>
</tr>
<tr>
<td>Crop</td>
<td>11.1*</td>
<td>9.3*</td>
<td>19.6*</td>
<td>102.9*</td>
</tr>
<tr>
<td>Herbicide Application Timing (HAT)</td>
<td>96.9*</td>
<td>10.9*</td>
<td>59.1*</td>
<td>35.2*</td>
</tr>
<tr>
<td>Year × Crop</td>
<td>20.0*</td>
<td>3.2*</td>
<td>1.2</td>
<td>8.3*</td>
</tr>
<tr>
<td>Year × HAT</td>
<td>9.1*</td>
<td>2.4*</td>
<td>2.4*</td>
<td>1.0</td>
</tr>
<tr>
<td>Crop × HAT</td>
<td>3.9*</td>
<td>2.3*</td>
<td>9.4*</td>
<td>12.5*</td>
</tr>
<tr>
<td>Year × Crop × HAT</td>
<td>3.7*</td>
<td>2.0*</td>
<td>1.2</td>
<td>2.5*</td>
</tr>
</tbody>
</table>

* indicates significance at p ≤ 0.05.
Palmer Amaranth Control 10 WAP
Data are pooled over years at Rocky Mount
Large Crabgrass Control 10 WAP
Data are pooled over years at Rocky Mount

Crop

Percent

NTC  2  6  2 & 4  4 & 6  2, 4, & 6

Competition

Cotton

Grain sorghum

Soybean
Large Crabgrass Control 10 WAP

Data are pooled over years at Rocky Mount

Crop

- Corn
- Cotton
- Grain sorghum
- Soybean

Percent

- NTC
- 2
- 6
- 2 & 4
- 4 & 6
- 2, 4, & 6
Percent Maximum Yield
Data are pooled over years at Rocky Mount

Crop
- Corn
- Cotton
- Grain sorghum
- Soybean

Legend:
- NTC
- 2
- 6
- 2 & 4
- 4 & 6
- 2, 4, & 6
Percent Maximum Yield
Data are pooled over years at Rocky Mount

Crop

- Corn
- Cotton
- Grain sorghum
- Soybean

Yield (%)

- NTC
- 2
- 6
- 2 & 4
- 4 & 6
- 2, 4, & 6

Legend:

- a
- b
- c
- d
- e
- f
- g

Significance levels indicated by different letters.
Estimated Economic Returns

Data are pooled over years at Rocky Mount

Crop
- NTC
- 2
- 6
- 2 & 4
- 4 & 6
- 2, 4, & 6
Subsequent Season Cotton
Year 2
Analysis of variance (P > F) for broadleaf and grass densities 3 WAP and cotton lint yield.

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>Broadleaf densities (3 WAP)</th>
<th>Grass densities (3 WAP)</th>
<th>Cotton lint yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment (Exp)</td>
<td>86.6*</td>
<td>24.6*</td>
<td>798*</td>
</tr>
<tr>
<td>Crop</td>
<td>22.7*</td>
<td>9.8*</td>
<td>4.7*</td>
</tr>
<tr>
<td>Herbicide application timing (HAT)</td>
<td><strong>9.1</strong>*</td>
<td>4.2*</td>
<td>0.4</td>
</tr>
<tr>
<td>Exp × Crop</td>
<td><strong>9.3</strong>*</td>
<td><strong>2.8</strong>*</td>
<td><strong>6.0</strong>*</td>
</tr>
<tr>
<td>Exp × HAT</td>
<td>0.9*</td>
<td>0.8</td>
<td>1.5</td>
</tr>
<tr>
<td>Crop × HAT</td>
<td>1.0</td>
<td><strong>2.1</strong>*</td>
<td>1.0</td>
</tr>
<tr>
<td>Exp × Crop × HAT</td>
<td>1.1</td>
<td>0.7</td>
<td>1.1</td>
</tr>
</tbody>
</table>

* indicates significance at \( p \leq 0.05 \).
Broadleaf Populations 3 WAP in Cotton

Data are pooled over experiments

<table>
<thead>
<tr>
<th>Herbicide Application Timing</th>
<th>Plants / m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>NTC</td>
<td>a</td>
</tr>
<tr>
<td>2</td>
<td>b</td>
</tr>
<tr>
<td>6</td>
<td>bc</td>
</tr>
<tr>
<td>2 &amp; 4</td>
<td>c</td>
</tr>
<tr>
<td>4 &amp; 6</td>
<td>b</td>
</tr>
<tr>
<td>2, 4, &amp; 6</td>
<td>c</td>
</tr>
</tbody>
</table>
Large Crabgrass Populations 3 WAP in Cotton

Rocky Mount

![Graph showing the comparison of crabgrass populations in different crops (Corn, Cotton, Grain sorghum, Soybean) between 2017 and 2018. The graph indicates the number of plants per m² for each year and crop, with different letters (a, b) indicating statistical significance.](image)
Summary

• Common ragweed control in corn and soybean was optimum when herbicides were applied at any time while cotton required two applications or a single application at 6 WAP

• A single herbicide application late generally was not as effective at controlling Palmer amaranth as it was controlling common ragweed

• In grain sorghum, greater control was noted when a 2 WAP application was included in the herbicide program

• When herbicides were not applied, maximum yield of corn was greatest of the four crops
Summary

- Estimated economic returns were greater for corn followed by soybean followed by cotton at Lewiston-Woodville in most cases when comparing timing of herbicide applications.
- Estimated economic returns often were similar for corn and soybean at Rocky Mount when comparing herbicide applications.
- Common ragweed populations were lower following corn.
- In one year, Palmer amaranth populations were greater following grain sorghum.
- Late season weed control ratings often reflected interactions of weed control and competition of the weed complex.
- Differences in herbicide efficacy across crops.
Impact of Weed Management on Peanut Yield and Weed Populations the Following Year

*Initially a component of Chapter 2
Annual grasses were controlled across the entire experiment to facilitate digging pods and inverting vines
Overall Summary

• Crop response to planting date was variable and reveals challenges
• There is potential for non-traditional double cropping systems in North Carolina under certain circumstances
• Generally, yields and economic returns were greater with the more intensive weed management programs
• Occasionally, weed management or crop in the previous season can have effects on weed populations the following season
• Contributions of weed seed to the soil seedbank may not be observed in a single season
Citations

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Questions