An Evaluation of the Efficacy of Defoliation Recommendations

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INFORMATION

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ABSTRACT

Cotton – the fabric of our lives. When thinking about cotton production, many of us automatically consider the importance of planting dates, variety, fertilizer applications, and insect and weed control. However, how many of us consider the importance of the final step, harvesting? Defoliation is the common practice that takes the cotton crop from active growth to preparation for harvest. The importance of properly administering this crucial step in cotton production is as important as some type of worm protection.

This study evaluated the efficacy of commonly applied defoliants recommended by the University of Tennessee Extension. The study evaluated each treatment option for percent open boll, percent defoliation, and regrowth/topgrowth potential. The research showed parallel results when compared to other defoliation studies.
DEDICATION

I would like to dedicate this research paper to all of my family for their support and encouragement of all my agricultural endeavors.

To Daddy and Momma, thank you for raising me on a farm and instilling in me the importance of hard work and dedication. My love of agriculture, farming, and the land is because of you. You have always loved me no matter what trials came our way and taught me the tough lessons of life whether I wanted to learn them or not. You have been there to support me in all of my accomplishments, both great and small.

To Papaw Tom, thank you for teaching me to love animals, especially those pigs. I know our time together is drawing to a close, but I cherish every minute we have left together and the memories I have of our good times. There were not many hog shows that you and Nannie missed. You were always my cheerleaders in the stand. Your presence meant so much to me!

To Mamaw Hazel, she does not know it but her illiteracy has been a constant source of encouragement for me to continue my education. You always told me how important my education was.

To Kerrie, thank you for proving that some accidents can be the best things in life.

To Allen, thanks for showing me that it is not always a bad thing to be hardheaded and stubborn. It actually pays off sometimes.

To Holly, thank you for showing me that everyone deserves a second chance.

To Mr. Albert and Mrs. Betty Jo, you have given me the best gift of all, your son.
To Spence, I still can not figure out how I ended up in this Master’s program and not you. Thank you for always encouraging me and giving me that push I need. You are my biggest fan and constructive critic. I know I have had to take time away from our home and marriage to complete this degree, and I thank you for understanding. Thanks for being my “bestest” friend of all.
ACKNOWLEDGEMENT

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To Tim Campbell, thank you for your input and recommendations associated with this research project.

To Bob Williams, thank you for your help with the statistical analysis of the data I collected during my research.

To H&H Farms, especially Jeremiah Hollingsworth, George Hollingsworth, Luke Hollingsworth, and Billy Ray McCorkle; you donated your time, labor, and crop for me to work with without any compensation, except a few pies of course. Without you this project would have never been completed.

I would also like to thank all the people I work with at the Dyersburg Boll Weevil Office, especially my boss Denise Clayton. You have all been so patient and encouraging to me. There are not many places of employment that would have been as lenient with my time as you have been. Thank you for all of your support.
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OBJECTIVES

➢ This study will evaluate the effectiveness of five defoliation treatments.

➢ Within the five treatments, one block in each unit will not be treated to evaluate the effects of no defoliant.

➢ Blocks will be checked for % open boll, % defoliation, and the potential for regrowth/topgrowth after the initial treatment at day 7 and day 14.

➢ A comparison of dollars of inputs verses results will be made.
CHAPTER 1

Introduction

The Importance of Cotton

Cotton, scientifically known as *Gossypium*, seems to be a common thread that runs throughout our everyday lives. We probably use a cotton wash cloth every morning in the shower and more than likely sleep on cotton sheets when we lay down at night. Most of us from day to day are dressed in cotton from our shirts to our shoelaces. We know the importance of our daily uses of cotton, but what are some other important facts about cotton?

"White Gold", cotton’s historical name, plays an important role in the economy for the United States and for Tennessee both. In today’s world, we use more cotton than any other fiber causing it to be the leading cash crop for the United State’s. Just at the farm level for the United States more than four billion dollars worth of supplies are used to produce this crop. Business revenue in it’s entirety for the United State’s cotton production is estimated at $122.4 billion (Thinkquest 2003.) Tennessee ranks eighth in the United States in cotton production (Kenerson 2003.)

In Tennessee, cotton seems to play the same role. Cotton is a very important crop for Tennessee, and ranks third in the state’s cash receipts (Shelby 2000). For the crop year of 2003 alone, the value of cotton receipts totaled more than $232.5 million (Kenerson 2003.) While all of this sounds great for the economy, the growers still have to have high production rates to get these numbers where they are. With less than two
rates from biotech seeds to more efficient harvesting. One of the most important steps in this process is that of defoliation. Defoliation is an important management practice associated with high yields and high quality cotton (Crops 2003).

With defoliation being one of the most important steps in cotton production, it also tends to be one of the trickiest. There are so many variables involved in the defoliation process including weather, stage of crop, and application methods just to name a few. Even after almost forty years of research in this area, results sometimes still can not be predicted and are sometimes even undesirable. However, further research is still needed on present day defoliants for Tennessee cotton.
CHAPTER 2

Literature Review

What is defoliation?

Defoliation, also known as leaf abscission or shedding of leaves, in cotton occurs naturally as a result of maturity. Defoliation, in its natural physiological process, usually is inadequate or not timely enough for a complete mechanical cotton harvest (Ayala and Silvertooth, 2001.) Causes of defoliation in cotton can include frost, disease, drought, or mineral deficiencies. Because of timing issues and quality issues, growers have turned to harvest aids to help in the defoliation process.

What are harvest aid chemicals?

The mechanization of cotton harvesting began in the late 1940’s, and by the mid 1960’s nearly all of the cotton in the United States was mechanically harvested (Funk et al 2004.) Since that time, harvest aid chemicals have been introduced to help facilitate machine harvesting. Harvest aids perform several functions in the production of cotton, including acting as defoliants which aid in the removal of both mature and juvenile leaves (Brown and Jost, 2003.) There are three main types of harvest aids, with each of the three having a very distinct purpose. Included in these are defoliants, desiccants, and boll openers. Defoliants are used for making the cotton plant drop its leaves, desiccants cause plant material to wither and dry, and boll openers do just what their name says.

Types of defoliants

Defoliants can be further broke down into two classes based on modes of action:
abscission and leaf drop in the plant (Craig 2004.) The trick to these type defoliants is that if the rate is too high, then desiccation, or “leaf stick”, occurs instead of defoliation (leaf drop). Hormonal defoliants are known as ethephon products and cause an increase in ethylene synthesis in the plant. Ethephon products release ethylene, stimulating further ethylene synthesis in the plant, resulting in abscission zone formation in the boll walls and leaf petioles (Craig 2004.) Another type of hormonal defoliant is a cytokinin. In most circumstances cytokinins promote leaf health, but with cotton and other close species it is the direct opposite. In cotton, cytokinins act as a defoliant by promoting ethylene synthesis. Since these hormonal type defoliants directly bypass herbicidal injury to the plant, it is not as likely that they will cause desiccation (leaf stick) compared to herbicidal defoliants.

**Physiology of Cotton Defoliation**

As mentioned before, defoliation in cotton is a natural physiological process. The first priority in a plant’s allocation of nutrients is to maturing bolls. As a cotton plant heavily loaded with fruit matures, it will transfer nutrients in the leaves to the maturing bolls. This process helps in the maturing of bolls, but also helps in the defoliation of the leaves. There are four main changes that occur with natural plant aging. The first is the loss of ribonucleic acids (RNA) and chlorophyll in the leaves. Both of these play important roles in younger plants. The ribonucleic acids are important in protein synthesis, while the chlorophyll helps the plant look green and also captures energy from sunlight to produce chemical energy in the form of carbohydrates (Ayala and Silvertooth, 2001.). The next change that occurs is a drop in levels of protein, carbohydrates, and
converted by the plant into simpler forms and then transported with the inorganic ions from the leaves to the bolls. The bolls are considered by the plant the highest priority. The third change is the anthocyanins (colored pigments) increase in the plant’s leaves. The last step is the change in hormonal concentrations. Hormone balance within a plant is contributed to mainly by the plant’s environment. Defoliation is affected directly by hormone levels stimulating or inhibiting enzyme production. There are five basic plant hormones including auxins (indole-acetic acid), Bscissi acid (ABA), ethylene, gibberellins, and cytokinins. The auxin hormones retard abscission in leaves, the Bscissi acid and ethylene both promote leaf abscission, and the gibberellins and cytokins both have variable effects.

The defoliation process in cotton is a complex one, but can be constructed as follows. The first step that takes place in the defoliation of cotton is that an internal shift occurs within the plant’s hormonal balance, as stated earlier this is usually a result of a change in the environment. The next step occurs near the junction of the petiole and the stem where the abscission zone (layer) is formed. After these two processes, the synthesis and secretion of enzymes such as cellulases and pectinases occurs. The secreted enzymes then digest the cell walls and middle lamella between certain cells of the abscission zone (Ayala and Silvertooth, 2001.) Finally the cells located on the stem side of the abscission layer expand while the cells on the leaf side shrink. This process causes the petiole to separate from the stem causing leaf defoliation. Below in Figure 1 is a summary of the events that take place with defoliation.
<table>
<thead>
<tr>
<th>Step 1</th>
<th>Environmental Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 2</td>
<td>Change in Hormonal Balance</td>
</tr>
<tr>
<td>Step 3</td>
<td>Pectinases and Cellulases Secreted in the Abscission Zone</td>
</tr>
<tr>
<td>Step 4</td>
<td>Digestion of Cell Walls and Cells of Middle Lamella</td>
</tr>
<tr>
<td>Step 5</td>
<td>Expanding and Shrinking of Cells causing Unequal Growth and Pressure</td>
</tr>
<tr>
<td>Step 6</td>
<td>Defoliation (Leaf Drop)</td>
</tr>
</tbody>
</table>

**Figure 1. Summary of Defoliation Events**

**The Importance of Defoliation**

Most cotton growers measure their success by high yields, but along with high yields the quality of cotton must be considered. A grower that manages their crop for quality as well as yield can help maximize their returns by receiving premiums at the gin (Bayer 2004.) Although most fiber qualities are determined early in a plant’s life, they are influenced even up to harvest. Defoliation programs (harvest aid programs) that include appropriate timing defoliation and minimum exposure of the open bolls to weather conditions prove essential to a high quality cotton crop that is inherently needed. Defoliation is one of the most important management tool that can be associated with high yields and good quality of cotton. Within this realm of importance are three main categories that defoliation aids in including facilitating machine harvesting, maintaining
The Benefits of Defoliation

The benefits associated with proper defoliation techniques are numerous in number. One of the most important benefits from defoliation is improved harvest efficiency. Green leaves that remain attached to the stalk can interfere with access of the lint to the spindles of the harvester, which can lead to lower harvest efficiencies, because some cotton is left in the field (Funk et al 2004.) Also, the juices that remain in green leaves tend to leave picker spindles gummy, which leads to more cleaning time and delays in harvesting.

Another very important benefit in cotton defoliation is that of improved fiber quality. During the process of harvesting, the lint is rubbed against the plant’s remaining green leaves. Chlorophyll in these leaves stain the fiber, causing lower price grades (Funk et al 2004.) Lint value is also reduced by high levels of leaf trash. Also, another thought that growers have is skipping the application of defoliants and waiting for a hard killing frost to get rid of the remaining leaves. The problem that is associated with this thought is that the fiber is left exposed to all weather conditions and late season insects seem to leave honeydew which also causing problems. All of this leads reduction in yields and the value of the lint.

Some other benefits to consider is the fact that defoliated fields seem to dry out quicker in the mornings, allowing the machine harvesters to run more hours in the day. Also a benefit, especially for the Boll Weevil Eradication Program, is that defoliation cuts off the food source for those late season insects that are getting ready to hibernate for the winter. Under certain condition, most importantly rank cotton, defoliation has
These are just some of the many benefits from cotton defoliation. Listed below in Figure 2 is a fairly complete list.

<table>
<thead>
<tr>
<th>Leaf removal</th>
<th>Elimination of primary source of lint stain and trash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improves cotton grades</td>
<td>Helps prevent boll rot</td>
</tr>
<tr>
<td>Reduced food source for insects going into diapause</td>
<td>Improves picker efficiency</td>
</tr>
<tr>
<td>Allows harvest to begin earlier in the season</td>
<td>Allows dew to dry faster, putting pickers to work earlier in the day</td>
</tr>
<tr>
<td>Reduces moisture</td>
<td>Improves storage in modules</td>
</tr>
</tbody>
</table>

**Figure 2. Benefits From Defoliation**

**Factors To Consider When Defoliating**

The most important factor to consider when defoliation time rolls around is that of boll maturity. Little or no boll maturation occurs after the leaves are removed, so premature leaf removal can lead to reduced yield and quality (Craig and Hayes, 2004.) A general “safe” guideline to go by is when 50-60 % of bolls are open and there is maturity in the youngest bolls, usually these will be 36-40 days old. A study was conducted in Georgia over a three year period of time. During this study, the effects of harvest aid application timing and subsequent harvest efficiency were measured. The studies indicated that maximum lint quality was obtained when harvest aids were applied
Another important factor to consider is weather. Defoliants work best on mature cotton under warm, humid, and sunny conditions (Craig 2004.) Applications of defoliants should be made when the weather is predicted to stay in these conditions for at least 3-4 days. Cool temperatures (60F) even up to five days after application can lead to a reduction in the defoliant activity because of slowed plant processes. High humidity allows the chemical to stay on the leaves for longer periods, allowing for more absorption. Also, when atmospheric moisture is high the moisture content in the leaves remain high, thus aiding in the movement of the chemicals. The other factor is weather. Although it is not fully understood, cotton defoliants work better under sunny conditions than on cloudy days even with the same temperature (MSU Extension 2003.)

The other important factor to consider when defoliating is the plant conditions. Defoliation has been proven to work better in cotton that is mature and loaded with fruit, and that is uniform in stand and size. Plants are more easily defoliated if cultural practices carried out through the growing season are geared toward promoting well-fruited plants that mature evenly and early (MSU Extension 2003.) These practices include the use of plant growth regulators to manage plant canopy. Cotton that has stopped both vegetative and reproductive growth are easier to defoliate.

A few other factors to consider include that of chemical coverage. Some of the products used in defoliation do not move throughout the plant, so coverage of the entire plant is very important. In order to achieve this effect, cone type nozzles seem to be better than flat fan air inducted nozzles to insure good foliar coverage. Also, you should
capacity can handle. Defoliants are recommended to be applied 10-14 days prior to your scheduled harvest.

**Deciding When to Defoliate**

Deciding when to apply defoliants is a very hard decision to make, especially when you cannot predict the weather and may need to be more than one place at a time. However, there have been some proven methods to help you decide on your cotton’s maturity. These methods include the NAWF5 + 850 DD60’s, percent open boll, NACB, the sharp knife technique, and the Hal Lewis method.

The first of these is node above white flower (NAWF) number 5 plus 850 degrees day (DD) 60’s. These are a lot of numbers and abbreviations to simply say to use this method a record should be kept of heat units accumulated after a white flower has bloomed five nodes or less down a plant from the top. This practice should probably only be used in conjunction with other more confident methods.

The next is the percent open boll method. This is probably the most widely used technique for determining defoliation timing and is considered the standard. This method should never be estimated from a truck. In order to more correctly determine percent open boll, three feet of row should be measured in ten places throughout the field. All bolls both open and closed should be counted and then a percent derived from these counts. While this method is the “old standby”, consideration should be given as well to crop age and how long open bolls have been exposed to the weather.

Node above cracked boll (NACB) is next indicator in the predictors of maturity.
this number should be at most four for proper defoliation. Once this uppermost boll is found, it should be cut open to inspect the lint and seed. If this boll is immature, then wait until NACB is three.

The sharp knife techniques should be included in all checks to help validate proper defoliation timing. The uppermost yield contributing boll should be pulled and a cross section be cut with a sharp knife. If the inside of the boll contains folded cotyledons, darkened seed coats, and no jelly, then it is considered mature.

The last method is the Hal Lewis method. While this method is not used often, it has gained some momentum over the last several years. This method involves taking a representative sample of the four bottom first position bolls and comparing the micronaire to a prediction chart. If the whole field micronaire is concluded to be in the discount range, then defoliation is recommended (Craig 2004.) This technique has the possibilities of maintaining high yields and saving the producer from discounts.

No matter which method is preferred, it is always best to use a combination of techniques to help ensure a good job from defoliation applications.

**Sources of Application**

There are two primary ways of applying harvest aids, by ground rigs and by aerial applicators. Conventional high-clearance spray rigs with wheel shields are capable of good defoliant applications with minimum crop damage (MSU Extension 2004.) In recent years a shift has been made to high volume and pressure to enhance boll opening and eliminate the need for dual applications. It is still recommended to use at least ten gallons of fluid per acre to obtain satisfactory results fifteen to twenty-five gallons of
boom. Cone type nozzles are recommended for the most efficient coverage of plant foliage. In aerial applications, the same rules apply except somewhere between four and eight gallons of water are suggested to be applied. Two suggestions made by the University of Tennessee are to use cone type nozzles and have an application volume of at least fifteen gallons per acre (Craig 2004.) Using more water volume and drift reduction nozzles may pay for itself with better defoliation results.
CHAPTER 3

Materials and Methods

Plot Design

A plot design was figured using the EDGAR website. The design was configured into a randomized complete block design using five treatments with three replications of each. The design given was as follows:

<table>
<thead>
<tr>
<th>BLOCK</th>
<th>UNIT</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>A</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>C</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>D</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>E</td>
</tr>
<tr>
<td>1</td>
<td>5</td>
<td>B</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>A</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>E</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>B</td>
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<tr>
<td>2</td>
<td>4</td>
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<td>2</td>
<td>5</td>
<td>C</td>
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<td>3</td>
<td>1</td>
<td>B</td>
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<tr>
<td>3</td>
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<td>A</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>C</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>D</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>E</td>
</tr>
</tbody>
</table>

Figure 3. Randomized Complete Block Design

Set-Up

Field trials were conducted during the fall of 2004 in West Tennessee on a farm
plot of cotton that was planted on May 2, 2004. The variety was Paymaster 1218 BG/RR and was planted on 38” rows. The temperature was 64°F, wind was calm, humidity was at 34%, and cloud cover was at 30-40%. Weather conditions were less than perfect, but were favorable for this time of year. Less than .10” of rainfall occurred during the night, allowing at least a twelve hour time period between application and precipitation. A 6500 John Deere spray rig with 24 row capacity was used to make the treatment applications. Approximately 2 acres of cotton were treated within each unit according to the monitor on the spray rig.

**Treatments**

Five treatments were used in this field study, and each was randomly replicated three times. The treatments were as follows:

| Treatment A | 0.5 oz Aim  
|             | 10.0 oz Def 6  
|             | 8.0 oz Prep  
|             | *(UT recommendation)* |
| Treatment B | 16.0 oz Def 6  
|             | *(UT recommendation)* |
| Treatment C | 32.0 oz Finish 6 Pro  
|             | *(UT recommendation)* |
| Treatment D | 6.0 oz Def 6  
|             | 32.0 oz Finish 6 Pro  
|             | 8.0 oz Prep  
|             | *(UT recommendation)* |
| Treatment E | No Treatment/Natural Defoliation |

**Figure 4. Treatments**
Def 6 is a phosphate type material that has been a standard defoliant in Tennessee for years. The performance level of Def 6 is effective over a broad range of conditions and usually causes rapid leaf removal. Leaf stick may happen under very hot conditions, and surfactants are not needed unless applying in adverse conditions. Also, the lower rates should only be used under ideal situations. Def 6 does not inhibit regrowth or help with boll opening.

Aim is a herbicidal defoliant similar to Def 6. Aim has excellent activity in desiccation of juvenile growth, but does not inhibit growth or contribute to boll opening. Aim is suitable for most mixtures, but caution should be applied since its “burning” action is so quick on leaves.

Finish 6 Pro can be used as a defoliant and a boll opener and in some cases can be used as a stand alone product. Finish contains ethephon and the synergist cyclanilide that aid in defoliation. Finish exhibits a limited level of regrowth inhibition.

Prep is an ethephon product that aids in the process of boll opening. The ingredients in Prep also make it available to enhance defoliation at higher rates.

**Procedures**

Each of the treatments were applied with water for a final spray volume of ten gallons per acre. Each unit was scouted on day seven and fourteen after the initial application. Each was checked for percent open boll, percent defoliation, and regrowth/top growth potential. A rating was given for each. Percent open boll was figured by randomly sampling three row feet in ten locations across each unit. A
unit. Regrowth/top growth potential was rated for each unit using a scale of poor, fair, good, and excellent. After day fourteen and all units sampled, a blanket aerial spray was made using a treatment of eight ounces of Def 6 and sixteen ounces of Prep with a final spray volume with water being three gallons per acre.

**Statistical Analysis**

All data was subjected to ANOVA using PROC GLM in the SAS system (SAS 1990.) The means for each treatment were separated, with $P \leq 0.05$, using Fisher’s Protected Least Significant Difference test.
CHAPTER 4

Results

Differences in percent open boll were found across the treatments during the October 7th and October 14th check. On October 7th differences were found and grouped as follows: treatment A and D, treatment C, and treatment B and E. Treatments A and D were found to have a mean percent open boll of at least 72.53 percent. This presented as statistically different from the other two groups having at least 70.00 percent and 60.53 percent open boll, respectively. The same was true for the October 14th check, with only a few variations. Treatments were grouped together as follows: treatment D, treatment A and C, and treatment B and E. Treatment D was found to have a mean percent open boll of 77.73 percent. This percentage also presented as statistically different from the other two groups with at least 74.47 percent and 63.87 percent open boll, respectively.

The other data collected from this research, including the percent defoliation and regrowth/top growth rating, backed these findings. The charts below help to illustrate this fact. As you can see, treatment D excelled in all areas except the regrowth/topgrowth potential category.
Figure 5. October 7th Rating Comparisons

Figure 6. October 14th Rating Comparisons
However, these figures were visual estimates since there was no scientific way to measure them, and could not be used on their own in this test. They are still a very important piece of this experiment, especially since they concur with the percent open boll findings.

Although the costs associated with each treatment was not figured as part of the statistical analysis, you can easily see a dramatic difference in each treatment. It is also obvious that sometimes it is better to spend more money at the initial point than to have to spend extra in the end to make up for poor performance.
CHAPTER 5

Conclusion

As a crop consultant, one is asked many questions during a growing season. Many factors must be taken into consideration for each question asked. One must keep in mind that not only is their professional reputation at risk, but also a person’s livelihood. After careful consideration of this research and its results, including crop stage, weather, and costs, one could easily reach a conclusion. Although treatment D appeared to be superior in this test, treatment A showed no statistical difference in the October 7th rating. With costs and efficiency taken into consideration treatment A would be selected. The following graphs help illustrate this point.

![Cost vs. Effectiveness Graph](image)

**Figure 7.** October 7th Cost Versus Effectiveness Graph
**Figure 8.** *October 14th Cost Verses Effectiveness Graph*

*Number values were assigned to the letter groupings for graphing purposes, they are as follows: $A = 15$, $B = 10$, and $C = 5$. Hence, all letter value rows with a value of 15 were grouped together and assumed to have no statistical differences.*
TABLES

Table 1.
Estimated mean of percent open boll produced over populations of cotton being exposed to Treatments A, B, C, D, and E averaged across three replications in West Tennessee, October 7, 2004.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>72.53 a</td>
</tr>
<tr>
<td>B</td>
<td>60.53 c</td>
</tr>
<tr>
<td>C</td>
<td>70.00 b</td>
</tr>
<tr>
<td>D</td>
<td>73.83 a</td>
</tr>
<tr>
<td>E</td>
<td>60.70 c</td>
</tr>
</tbody>
</table>

Means with the same letter are not significantly different, Fisher’s Protected LSD ($P \leq 0.05$)

Table 2.
Estimated mean of percent open boll produced over populations of cotton being exposed to Treatments A, B, C, D, and E averaged across three replications in West Tennessee, October 14, 2004.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>75.83 b</td>
</tr>
<tr>
<td>B</td>
<td>64.50 c</td>
</tr>
<tr>
<td>C</td>
<td>74.47 b</td>
</tr>
<tr>
<td>D</td>
<td>77.73 a</td>
</tr>
<tr>
<td>E</td>
<td>63.87 c</td>
</tr>
</tbody>
</table>

Means with the same letter are not significantly different, Fisher’s Protected LSD ($P \leq 0.05$)
### Table 3.
Treatment Costs

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>$8.64</td>
</tr>
<tr>
<td>B</td>
<td>$5.60</td>
</tr>
<tr>
<td>C</td>
<td>$15.68</td>
</tr>
<tr>
<td>D</td>
<td>$20.02</td>
</tr>
<tr>
<td>E</td>
<td>$0.00</td>
</tr>
</tbody>
</table>

*All costs figured using current price list from Tennessee Farmer’s Cooperative.*
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