# Table of Contents

Chapter 1. Literature Review .............................................................. 1  
  1.1 Growing Tomatoes by Plasticulture ........................................... 1  
  1.2 Tomato Plant Diseases ............................................................ 4  
  1.3 Copper as a Crop Protectant ................................................... 6  
  1.4 Copper Toxicity ...................................................................... 7  
  1.5 Regulations on Copper in Waterways ....................................... 13  
  1.6 Programs to Minimize Non-Point Source Pollution ................. 15  
Chapter 2. References ................................................................. 20  
Chapter 3. Introduction ................................................................. 25  
Chapter 4. Methods and Materials ................................................... 31  
  4.1 Setup of Greenhouse-Scale Simulation ...................................... 31  
  4.2 Sample Collection Procedure ................................................ 33  
  4.3 Sample Analysis Procedures .................................................. 34  
Chapter 5. Results ........................................................................... 36  
  5.1 Tomato Plants ......................................................................... 36  
  5.2 Runoff and Groundwater ........................................................ 36  
  5.3 Distribution of Copper-based Crop Protectant ......................... 38  
  5.4 Effectiveness of Sedimentation Control ..................................... 39  
Chapter 6. Discussion ....................................................................... 41  
Chapter 7. Conclusions .................................................................... 44  
Chapter 8. References ....................................................................... 46  
Chapter 9. Appendix A: Background Data ......................................... 62  
Chapter 10. Appendix B: Copper Sorption to Soil ......................... 68  
       9.1 Chapter 11. Appendix C: Copper Desorption in Estuarine Water .... 71
List of Tables

Methods and Materials

Table 1. Date and Quantity of Applied Copper-based Crop Protectant in Relation to Simulated Rain Events ................................................................. 50

Appendix A: Background Data

Table 2: Baseline Copper Concentration of Bojac Sandy Loam .......... 63
Table 3: Bojac Sandy Loam Isotherm Results ..................................... 64
Table 4: Copper Sorption of Construction Materials ......................... 65
Table 5: Copper Leaching of Construction Materials ......................... 66

Appendix C: Copper Desorption in Estuarine Water

Table 6. Copper Desorption From Soil Into Estuarine Waters .............. 72
List of Figures

Methods and Materials

Figure 1. Cross-Sectional View of a Constructed Tomato Field ....................... 51

Results

Figure 2. Average Total Suspended Solids Concentrations in Runoff .......... 52
Figure 3. Average Copper Concentrations in Runoff .................................... 53
Figure 4. Box Plot of Volumes of Runoff and Groundwater Generated ........ 54
Figure 5. Locations in which Soil Cores Were Taken ................................... 55
Figure 6. Copper Distribution in Top 2.5 Centimeters of Soil ....................... 56
Figure 7. Distribution of Copper Along Soil Depth ....................................... 57
Figure 8. Mean Percent Distribution of the One-Percent Applied Copper Mass That Left the Plasticulture Fields ................................................... 58
Figure 9. Determination of Runoff Suspended Solids Settling Rate Using Imhoff Cones ................................................................. 59
Figure 10. Comparison of Total and Dissolved Copper Concentrations Before and After Settling ................................................................. 60
Figure 11. Change in Copper Concentration During Settling Period ........... 61

Appendix A: Background Data

Figure 12. Measured versus Calculated Copper Sorbed to Suspended Solids.... 67

Appendix B: Copper Sorption to Soil

Figure 13: Copper Distribution in Soil at Bottom 5-Centimeters of Depth .... 69
Figure 14: Copper Distribution in the Top 2.5-Centimeters of Soil ............... 70

Appendix C: Copper Desorption in Estuarine Waters

Figure 15. Copper Desorption From Soil Into Estuarine Water .................. 73