IMPACT OF HERBIVORY BY COTTONWOOD LEAF BEETLE ON THREE SELECTED COTTONWOOD CLONES: YEAR 2 RESULTS

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Abstract—Defoliation by herbivores, especially the cottonwood leaf beetle (CLB) (*Chrysomela scripta* F.), is a concern in the management of eastern cottonwood. In 2003, an 8-year study was initiated to determine the impact of herbivores on three selected eastern cottonwood clones. The plantation is located near Hayti, MO, on property managed by MeadWestvaco. Each clone was planted in 100 tree plots in each of 8 blocks for a total of 2,400 trees in the study. Four of the 8 blocks (1,200 trees) were not protected from defoliation, and the remaining 4 were treated with an insecticide to control CLB and other incidental herbivores. The 8-year objective is to determine the overall losses and/or gains associated with controlling and not-controlling defoliation primarily by the CLB. During the 2003 and 2004 growing seasons, monthly height, ground-line diameter (gld) (2003), diameter at breast height (d.b.h.) (2004), and degree of defoliation were recorded and statistically analyzed. Comparisons of the results of the first 2 years of this 8-year study are presented.

INTRODUCTION

Eastern cottonwood (*Populus deltoides* Marshall) has received increased interest over the past 2 decades as a short rotation species (Fang and Hart 2000). The relatively short rotation periods of 6 to 12 years make it a desirable species for fiber production, biomass energy, and carbon sequestration. With the advent of short rotation (intensive culture systems for growing tree crops), a concern has arisen over the potential of serious growth losses due to insect damage (Bassman and others 1982, Fang and others 2002). The primary insect pest of *Populus* species is the cottonwood leaf beetle (*Chrysomela scripta* F.) (fig. 1). The objective of this study is to determine the impact that CLB defoliation has on height, diameter, and mortality of cottonwood throughout a rotation.

STUDY SITE

A MeadWestvaco plantation, located just north of Hayti, Pemiscot County, MO, was chosen, and three clones (WV-90, WV-98, and WV-99) were selected and planted. There was a total of 8 blocks separated by 19 rows of trees. Each block contained all three clones. Each clone was planted in 100 (10 x 10) tree plots. Four of the eight blocks were not protected from defoliation (untreated), and the remaining four (treated) were treated with Sevin (carbaryl 80S at 0.6 pounds of active ingredient per acre) to control CLB feeding. In 2003, a total of six spray treatments were applied.

METHODS

Year One

The area was planted in June of 2003, following a late May flood. Monthly study plots were established using the inner 16 (4 x 4) trees of each plot. In July, a paint pen was used to mark the point at which the ground-line diameter (gld) was to be taken. This point was 10 inches from soil level. Gld was measured monthly using digital calipers. Height was also taken monthly using a measuring stick and/or a height pole. The annual study plots, consisting of the inner 36 (6 x 6) trees, were measured in January, 2004. Monthly damage ratings were completed on the inner 16 trees and were recorded in August, September, and October 2003, to assess the amount of defoliation. The damage rating system followed that described by Larson and Isebrands (1971) and Fang and Hart (2000). A value of 0 was assigned to trees with no feeding on

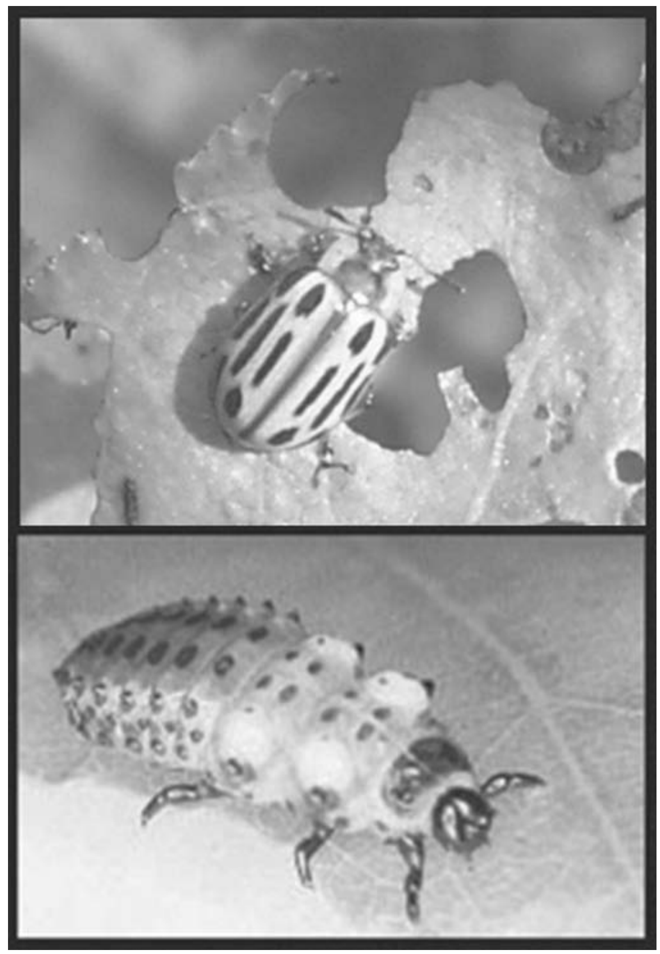

Figure 1—Mature adult and larva of the cottonwood leaf beetle.

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LPI (Leaf Plastochron Index) 1 to 8 leaves. Trees with light feeding or sample feeding on LPI 1 to 8 leaves were assigned a value of 1. Trees with light to moderate feeding with < 50 percent of LPI 1 to 8 leaves missing were assigned a value of 2. Trees with moderate to heavy feeding with 50 percent of LPI 1 to 8 leaves missing and the main leader still intact were assigned a value of 3. Trees with heavy damage with > 50 percent of LPI 1 to 8 leaves missing and with the main leader and terminal buds heavily damaged or destroyed were assigned a value of 4.

The data was collected and stored in a spreadsheet on field computers, then transferred to a spreadsheet on a desktop computer prior to analysis. Data were analyzed using SAS® PROC ANOVA and Fisher's PLSD (SAS Institute 2000) at $\alpha = 0.05$. In January 2004, above ground volume index was calculated using the formula [Volume Index = height * (gld^2)].

Year Two

Methods of data collection remained essentially the same as in 2003. Once trees had a measurable diameter at breast height (d.b.h.), gld measurements were not collected. D.b.h. was measured monthly using Haglof® Aluminum calipers, and height was measured using a height pole and/or Haglof® Vertex III hypsometer. Monthly damage ratings were recorded in May, June, July, August, September, and October 2004. Annual study plots were measured in January 2005. Annual data were used to calculate an index of the above ground volume using the formula [Volume Index = height * (dbh^2)].

RESULTS

Year One

Survival rate was not significantly different between treatments (untreated and treated blocks) at $\alpha = 0.05$. Survival rate across all clones was extremely high. Survival rate was 95.8 percent in the untreated blocks and 98.9 percent in the treated blocks. Damage ratings were significantly different among untreated and treated blocks. In treated blocks, feeding was minimal, while in untreated blocks, feeding was moderate to heavy (fig. 2). Damage ratings between untreated and treated blocks differed significantly each month. In August, 2003, the untreated blocks and treated blocks were significantly different (fig. 2). However, no significant differences were found between clones within the untreated blocks or treated blocks. WV-98UT, WV-99UT, and WV-90UT had average damage ratings of 2.15 ± 0.13, 1.97 ± 0.14, and 1.92 ± 0.14, respectively, while WV-90T, WV-98T, and WV-99T had average damage ratings of 0.79 ± 0.11, 0.59 ± 0.08, and 0.59 ± 0.05, respectively (fig. 2). Untreated and treated blocks had significant differences in both height and gld measurements over the entire study period in all three clones (fig. 3 and fig. 4a).

January 2004

Gld of clones WV-99UT and WV-90UT in the untreated blocks were found to have no significant difference, averaging 0.84 ± 0.03 and 0.80 ± 0.02 inches, respectively (fig. 4a). However, average gld of WV-98UT (1.08 ± 0.03 inches) was significantly different from WV-90UT and WV-99UT. Each of the clones in the treated blocks was significantly different, with average gld of 1.75 ± 0.03, 1.38 ± 0.03, and 1.19 ± 0.02 inches, respectively. Clone WV-98T had the largest gld, averaging 1.75 ± 0.03 inches (fig. 4a).

Heights of clones WV-98T, WV-99T, WV-90T, WV-98UT, WV-99UT, and WV-90UT in untreated and treated blocks were all significantly different, averaging 118.4 ± 1.7, 112.9 ± 1.3, 99.7 ± 1.4, 73.4 ± 1.8, 62.6 ± 1.8, and 57.8 ± 1.4 inches, respectively. WV-98T exhibited the largest height in both the untreated and treated blocks, averaging 118.4 ± 1.7 inches (fig. 3).

Volume Index is an important tool in determining volume loss and/or gains when comparing two or more treatments. For the first year, the volume loss for WV-90, WV-98, and WV-99 was 71, 72, and 74 percent, respectively, when comparing the treated and untreated clones (table 1).

Year Two

Survival rate among the clones within each treatment continued to be high. WV-99T and WV-98UT had the highest survival rates, 97.2 percent, while the lowest survival rate was 91.7 percent for WV-90UT. Damage ratings were not as high in 2004 as in 2003 (fig. 2). The highest damage rating was 3.0 for WV-98UT in June 2004. After June 2004, damage ratings for both untreated and treated blocks continued to

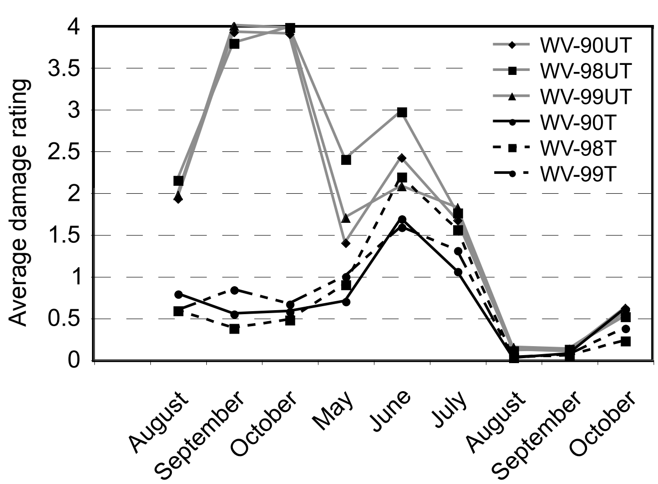

Figure 2—Average damage ratings of untreated and treated clones for the 2003 and 2004 growing season.

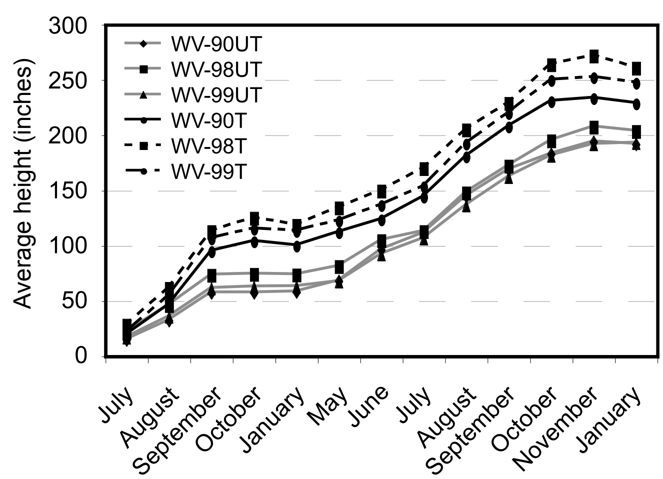

Figure 3—Average height of untreated and treated clones from July 2003 to January 2005.

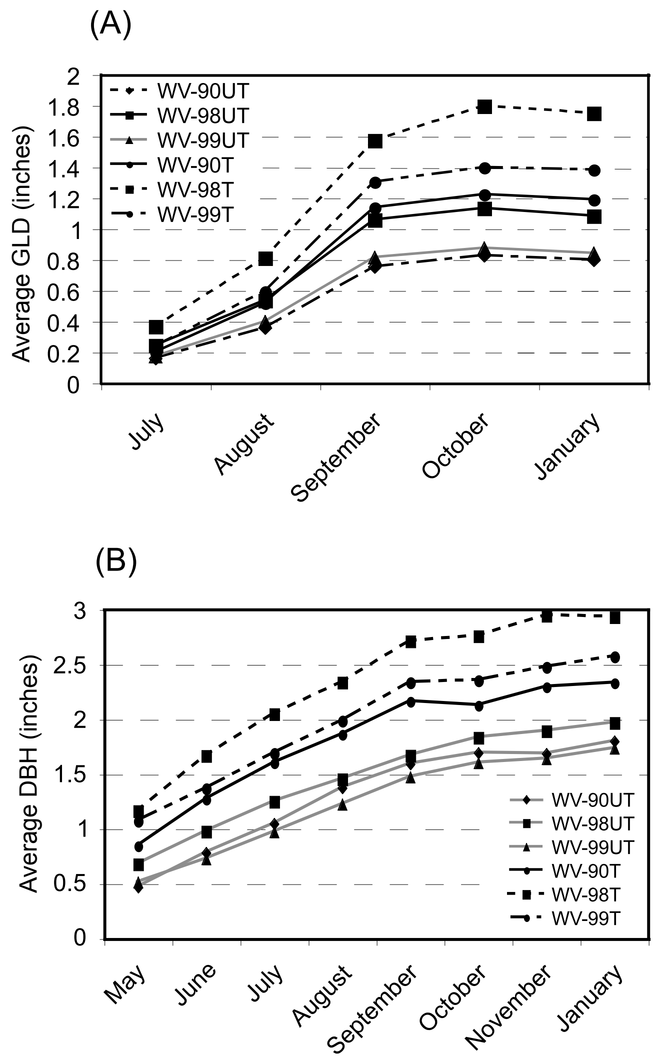

Figure 4—(A) Average ground-line diameter (gld) of untreated and treated clones from July 2003 to January 2004, (B) Average d.b.h. of untreated and treated clones from May 2004, to January 2005.

Table 1—Volume Index[a] shows the total volume loss between treated and untreated blocks for all clonal lines in January 2004

Clone	Treated	Untreated	Volume loss
	- - - - *cubic inches* - - - -		*percent*
WV-90	158	46	71
WV-98	401	111	72
WV-99	233	61	74

[a] Volume Index = height * $(gld)^2$.

decrease rapidly. For August, September, and October 2004, average damage ratings in each treatment were not greater than 0.62 (fig. 2).

January 2005

Diameter of clones WV-98UT and WV-90UT in untreated blocks were found to have no significant differences, averaging 1.92 ± 0.07 and 1.88 ± 0.05 inches, respectively (fig. 4b). However, average diameter of 1.72 ± 0.05 inches in WV-99UT was significantly less. Each of the clones (WV-98T, WV-99T, and WV-90T) in the treated blocks was significantly different, with average diameters of 2.86 ± 0.06, 2.54 ± 0.04, and 2.33 ± 0.03 inches, respectively. Clone WV-98T had the greatest diameter, averaging 2.86 ± 0.06 inches (fig. 4b).

Heights of clones WV-98T, WV-99T, and WV-90T in treated blocks were all significantly different, averaging 255.9 ± 3.7, 244.9 ± 1.8, and 226.6 ± 2.1 inches, respectively. WV-98T exhibited the greatest height growth in both the untreated and treated blocks, with an average height of 255.9 ± 3.7 inches (fig. 3). WV-98UT, WV-90UT, and WV-99UT were not significantly different with respect to mean tree heights, averaging 197.3 ± 3.9, 194.5 ± 2.5, and 192.2 ± 2.7 inches, respectively (fig. 3). The volume loss for WV-90, WV-98, and WV-99 was 39, 59, and 58 percent, respectively, when comparing the treated and untreated clones (table 2).

DISCUSSION

Feeding by CLB caused reduction in gld, d.b.h., and height. All clones showed dramatic reduction in above-ground volume index when comparing untreated and treated blocks. In January, 2004, average volume index loss across the stand was 72 percent. This observation is similar to an earlier study, where reduction in above-ground volume was as much as 73 percent (Coyle and others 2002). In January, 2005, average volume index loss across the stand was 52 percent. The volume loss in the second year was less than the first year's volume index loss and attributed to minimal CLB feeding during the 2004 growing season (fig. 2). Damage ratings show that growth is significantly affected by increased feeding. Results indicate tree volume increases significantly in the first and second years if CLB feeding is controlled. As age of the plantation increases, CLB damage should lessen. However, other pests such as the poplar borer (*Saperda calcarata* Say) may present a problem. It appears that cottonwood continues to gain popularity as a short rotation crop; therefore the need for controlling herbivory will continue.

Table 2—Volume Index[a] shows the total volume loss between treated and untreated blocks for all clonal lines in January, 2005

Clone	Treated	Untreated	Volume loss
	- - - - *cubic inches* - - - -		*percent*
WV-90	1,298	795	39
WV-98	2,335	969	59
WV-99	1,655	694	58

[a] Volume Index = height * $(dbh)^2$.

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