The Great Lakes Entomologist

Volume 14
Number 3 - Fall 1981 *Number 3 - Fall 1981*

Article 7

October 1981

# The Response of Aspen *(Populus Tremuloides)* to Artificial Defoliation

A. C. Hodson
*University of Minnesota*

# THE RESPONSE OF ASPEN *(POPULUS TREMULOIDES)* TO ARTIFICIAL DEFOLIATION[1]

A. C. Hodson[2]

In the summers of 1939 and 1940 hand defoliation of trembling aspen, *Populus tremuloides* Michx., was carried on in a young stand located a few miles north of Itasca State Park. This study was undertaken to determine the response of aspen trees to several amounts of defoliation at four different times during the summer. Other similar artificial defoliation studies have been reported by Wallace (1945), Giese et al. (1964), Skilling (1964), Kulman (1971), and Heichel and Turner (1976).

Leaf clusters, including the petioles, were removed without injuring the terminal shoots. The procedure was different from that caused by insect defoliation because clusters were taken uniformly over a tree starting with the first cluster on the lowest branch. The basal diameter of the trees ranged from 1.2 to 1.8 inches. Three similar trees were selected to be defoliated 50, 60, 70, 80, 90, and 100%. Groups of three trees were defoliated once during the summer on four dates, 3 June, 30 June, 14 July, and 19 August. Before the leaves were removed the number of leaf clusters was counted, the average number of leaves per cluster determined, and sample of leaves were measured to determine average leaf areas in square inches. From these data it was possible to calculate the average total leaf area on each of the trees. The same measurements were taken for the regenerated leaves produced soon after defoliation, and again for the leaves on the same trees in each of the following two years. In addition, the number of dead branches was recorded the first year after defoliation. The results presented in Table 1 are average values for three-tree samples.

The most striking feature is the response of the trees to defoliation after the middle of August. There was no refoliation after any level of defoliation. Also, leaf production each of the following two years was not significantly different from that of the undefoliated check trees, and the average leaf area of 1.4 to 1.6 square inches was the same as on check trees.

The percentage of leaf area regenerated was greatest following 90 and 100% defoliation with trees defoliated on 30 June generally showing the most refoliation. With the exception of 50% defoliation on 3 June and 100% on 14 July, the 14 July defoliation resulted in the smallest area regenerated. The size of the regenerated leaves also differed depending on the amount of foliage removed. For example, when the trees were defoliated on 30 June, the average leaf area in square inches, as compared with the original areas, was 72, 64, 61, 46, 33, and 35 for 50, 60, 70, 80, 90, and 100% defoliation respectively. The areas of leaves produced the year following defoliation showed a similar gradation of 100, 94, 86, 80, 53, and 43 for the same amounts of defoliation, and by the second year, the trees defoliated 90 and 100% still had average-sized leaves of only 75 and 53% of their original areas.

Heichel and Turner (1976) reported remarkably similar results after removing 100, 75, and 50% of the foliage from red oak and red maple trees. For example, these trees produced regrowth leaves with leaf areas only 39 and 33% of the primary leaves for oak and maple respectively after 100% defoliation. The leaf areas of the regrowth leaves in aspen were 35% as large as the original leaves. At the other extreme, after 50% defoliation, their regrowth leaves had areas 60 and 66% as large for oak and maple while the aspen leaves averaged 72% the size of normal leaves.

There was a gradation in recovery of the defoliated trees exhibited in each of the two years following the defoliation treatments. Because of the considerable variation in response with

[1]Paper No. 11,635, Scientific Journal Series, Minnesota Agricultural Experiment Station, University of Minnesota, St. Paul, MN 55108.

[2]Department of Entomology, Fisheries, and Wildlife, University of Minnesota, St. Paul, MN 55108.

Table 1. Effects of defoliation on average leaf area in square inches and average number dead branches.

| Defol. Date | Orig. Area | Area Re-generated | % of area removed Regenerated | 1 yr. later % of Orig. | 2 yrs. later % of Orig. | Dead Branches 1 yr. later |
|---|---|---|---|---|---|---|
| | | | **50% Defoliation** | | | |
| 3 June | 2385 | 49 | 4 | 124 | 177 | 2.3 |
| 30 June | 2381 | 83 | 7 | 164 | 203 | 4.0 |
| 14 July | 1051 | 79 | 15 | 106 | 137 | 2.1 |
| 19 Aug. | 1498 | 0 | 0 | 210 | 281 | 0.0 |
| | | | **60% Defoliation** | | | |
| 3 June | 2777 | 436 | 27 | 137 | 140 | 5.0 |
| 30 June | 2988 | 378 | 22 | 121 | 109 | 8.0 |
| 14 July | 1207 | 115 | 16 | 161 | 227 | 1.3 |
| 19 Aug. | 1176 | 0 | 0 | 197 | 315 | 0.0 |
| | | | **70% Defoliation** | | | |
| 3 June | 3106 | 543 | 25 | 90 | 96 | 5.0 |
| 30 June | 3756 | 761 | 29 | 64 | 75 | 7.6 |
| 14 July | 696 | 53 | 10 | 105 | 153 | 6.0 |
| 19 Aug. | 2040 | 0 | 0 | 134 | 216 | 0.0 |
| | | | **80% Defoliation** | | | |
| 3 June | 2162 | 406 | 23 | 82 | 102 | 4.6 |
| 30 June | 2750 | 818 | 37 | 113 | 155 | 7.3 |
| 14 July | 1143 | 146 | 16 | 100 | 134 | 5.3 |
| 19 Aug. | 1795 | 0 | 0 | 198 | 258 | 0.0 |
| | | | **90% Defoliation** | | | |
| 3 June | 2705 | 792 | 33 | 81 | 88 | 8.6 |
| 30 June | 3386 | 1017 | 33 | 51 | 83 | 15.0 |
| 14 July | 1271 | 313 | 27 | 81 | 89 | 11.5 |
| 19 Aug. | 2141 | 0 | 0 | 161 | 213 | 0.0 |
| | | | **100% Defoliation** | | | |
| 3 June | 2331 | 886 | 38 | 66 | 74 | 14.5 |
| 30 June | 2520 | 1092 | 43 | 35 | 45 | 16.0 |
| 14 July | 2038 | 1143 | 56 | 50 | 89 | 28.0 |
| 19 Aug. | 1471 | 0 | 0 | 179 | 214 | 0.0 |
| | | | **Check** | | | |
| 3 June | 2325 | 0 | 0 | 182 | 250 | 2.0 |
| 30 June | 2651 | 0 | 0 | 168 | 232 | 0.0 |

respect to defoliation date no consistent significant differences are evident. However, a marked reduction in recovery, given as percentage of the original leaf areas, occurred after 90 and 100% defoliation. In both cases there was significantly less total leaf area produced than by trees defoliated on 19 August and for the check trees. This condition persisted into the second year following the defoliation treatments.

Heichel and Turner (1976) also observed the response of their trees the year following defoliation and the results were much the same as found for aspen in this study. There was one marked difference. For their trees the reduction in total leaf area was imperceptible as compared to the total area of the previous year's primary foliage. In the present study, as mentioned above, there was a significant reduction in total leaf area after the most severe defoliation treatments. The number of dead branches observed the first year after defoliation also was much greater after 90 and 100% defoliation, though there were many more at all levels than for the checks and for the trees defoliated in August.

There was another phenomenon associated with different amounts of defoliation. In the year following the defoliation treatments leaves distorted in size and form, as the result of infestation by an unidentified eriophyid mite, appeared on some of the trees. These galls were found only on trees with 90 and 100% defoliation. Buds infested by these mites could be recognized in the fall by their large size and the presence in them of many overwintering mites. Galled leaves caused by this mite also have been commonly observed in years following complete defoliation of aspen by the forest tent caterpillar.

## LITERATURE CITED

Giese, R. L., J. E. Kaplor, and D. M. Benjamin. 1964. Defoliation and the genesis of maple blight. Part IV. pp. 80–113, *in* Studies of maple blight. Univ. Wisconsin Res. Bull. 250.

Heichel, G. H. and N. C. Turner. 1976. Phenology and leaf growth of defoliated hardwood trees. pp. 31–40, *in* Perspectives in forest entomology. Academic Press.

Kulman, H. M. 1971. Effects of insect defoliation on growth and mortality of trees. Ann. Rev. Entomol. 16:289–324.

Rose, A. H. 1958. The effect of defoliation on foliage production and radial growth of quaking aspen. For. Sci. 4:335–342.

Skilling, D. D. 1964. Ecological factors associated with maple blight. Part V. pp. 115–128, *in* Studies of maple blight. Univ. Wisconsin Res. Bull. 250.

Wallace, P. P. 1945. Certain effects of defoliation of deciduous trees. Connecticut Agric. Expt. Sta. Bull. 488:358–373.