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Rink et al.: <i>Acrobasis</i> Shoot Moth (Lepidoptera: Pyralidae) Infestation-

ACROBASIS SHOOT MOTH (LEPIDOPTERA: PYRALIDAE) INFESTATION-TREE HEIGHT LINK IN A YOUNG BLACK WALNUT PLANTATION

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ABSTRACT

Acrobasis shoot moth infestations were evaluated in a young black walnut progeny test for 4 years, from ages 3 to 6. Infestation levels were greatest on the largest trees in the fourth and fifth year after plantation establishment, and were declining by the sixth year. *Acrobasis* infestation appears to be a problem primarily on young trees less than 2.5 m in height. There was no evidence for genetic resistance to *Acrobasis* infestation in black walnut.

Black walnut (*Juglans nigra*) is commonly grown for production of high-quality veneer logs. Only trees with stems free of form defects, such as forks or crooks in the first 3 to 5 m, qualify as veneer logs. Stem defects in black walnut often result from loss of apical dominance due to damage or mortality of the terminal bud, often associated with late spring frosts. More recently, casebearer moths (*Acrobasis* spp.) have been shown to damage terminal shoots and buds of young black walnut trees when larvae tunnel into them. Our study was designed as a survey to assess damage to trees in a young plantation with a relatively serious *Acrobasis* infestation. Insect identification techniques followed those of McKeague and Simmons (1979).

METHODS

Open-pollinated seeds from 54 walnut trees were used to produce 1–0 seedlings for a progeny test. Parent trees were selected from within a 250-mile semi-circular radius south of the Shawnee National Forest in southern Illinois. This included an area bounded by southern Illinois, western Kentucky, western Tennessee, and southeast Kansas. However, most of the seed collections were from western Kentucky and western Tennessee. In most cases seed was collected from one tree per stand. Although trees of better than average form were sought at the time of collection, no rigid minimum selection criteria were applied. Seedling progeny resulting from these seed collections were planted in 5-tree row plots at a spacing of 1.8 m within rows and 3.7 m between rows, in a randomized complete block design with 10 blocks; upon establishment the plantation contained 2,700 trees.

The progeny test was established in early spring 1973 on a Haymond silt loam on the floodplain of Sexton Creek, on the Shawnee National Forest in Alexander

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County, Illinois. The site was an abandoned pasture on which 1.2 m strips were machine sprayed with a simazine, dalapon, 2,4-D mix before planting and spot sprayed in spring 1974 and 1975. In addition the plantation was mowed annually.

In 1976, after three growing seasons, we observed that many of the walnut trees were growing slowly, some were crooked or forked, and a few had died back and sprouted from near the base. We suspected insect attack as a possible cause of the poor form and began surveys for the following insects: *Acrobasis juglandis* (LeBaron), the pecan leaf casebearer; *A. demotella* Grote, the walnut shoot moth (Martinat and Wallner 1980); and *Xylosandrus germanus* (Blandf.), an ambrosia beetle. The ambrosia beetle was later associated with canker and dieback but not with crook or forking problems related to terminal buds (Weber and McPherson 1984).

During 1977–1979, we made two types of surveys, using the same sampling scheme for both. The surveys were done on a pilot basis in 1976 and repeated 1977–1979. First, during the dormant season, we counted 1 mm-long hibernacula containing overwintering larvae of *A. juglandis*; the hibernaculum is the overwintering case for the first instar larva. First instar larvae develop from eggs hatched in late summer; they spin hibernacula in preparation for overwinter hibernation. Presence of hibernacula on a tree was considered an indicator of susceptibility of the tree to *Acrobasis* infestation. Second, in the early summer, we counted infested growing shoots as a measure of damage by *A. demotella; A. juglandis* is a defoliator but does not tunnel into shoots (Martinat and Wilson 1979). One tree per family-row plot per block was randomly chosen (using a random number generator) for infestation evaluation each fall; the same tree was evaluated the following spring. All insect and infested shoot count data were square root transformed to increase normality. Tree height was measured to the nearest cm during the dormant season.

Data were analyzed by analysis of variance and covariance and correlation techniques. Family heritabilities were calculated using the $H^2 = (1-1/F)$ formula of Kung and Bey (1979) in which F is the variance ratio for families.

RESULTS AND DISCUSSION

During our 4-year evaluation of this plantation, height growth averaged 0.36 m annually. Mean total tree height was 1.5 m in 1976 and the plantation average was 2.9 m by the end of the 1980 growing season. Infestation as reflected by the number of hibernacula per tree increased from 1.4 in 1976 to a high of 2.6 in 1978 and declined to 2.0 hibernacula per tree in 1979. Demographic trends established by *Acrobasis* hibernacula were mirrored by the number of infested twigs per tree, which increased from 1.3 in 1976 to 2.3 in 1978 and then declined to 1.7 in 1979 (table 1). However, during the 1976–1979 period, the number of trees with hibernacula increased from 20 percent in 1976 to 33 percent in 1977, 44 percent in 1978, and 57 percent in 1979. Similarly, the number of trees with infested twigs increased from 20 percent in 1976 to 30 percent in 1977, 58 percent in 1978, and 63 percent in 1979.

Analyses of variance or covariance failed to disclose any significant family effects. Heritability of susceptibility to infestation by *Acrobasis* was less than 0.15, confirming that genetic resistance to *Acrobasis* damage is extremely low or nonexistent. Similarly there was no correlation between either number of hibernacula or number of infested twigs and latitude or longitude of family origin.

Correlation analysis disclosed a pattern of very high positive correlations between the number of hibernacula per tree and the number of infested twigs ($0.87 < r < 0.97$). These high correlations were expected and suggest that the parameters measure similar attributes of *Acrobasis* infestation and that future surveys probably need to measure only one of these parameters. The high correlations also suggest that overwintering survival rates were high and parasitism/predator levels were low.

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Table 1.—Average height (m), height growth (m), number of hibernacula per tree (no.) and number of infested twigs

Variable	Mean	Minimum	Maximum
Height 76	1.5	0.2	2.9
Height 77	1.8	0.4	3.6
Height 78	2.1	0.4	4.4
Height 79	2.4	0.6	5.5
Height 80	2.9	0.8	6.1
Ht. Gr. 76–77	0.35	-0.63	1.39
Ht. Gr. 77–78	0.26	-1.15	1.67
Ht. Gr. 78–79	0.35	-0.90	2.78
Ht. Gr. 79–80	0.46	-2.55	2.02
Hib. 76	1.4	1.0	7.0
Hib. 77	2.0	1.0	14.0
Hib. 78	2.6	1.0	16.0
Hib. 79	2.0	1.0	3.0
Infest. 76	1.3	1.0	15.0
Infest. 77	1.7	1.0	3.0
Infest. 78	2.3	1.0	14.0
Infest. 79	1.7	1.0	9.0

Table 2.—Correlations of number of hibernacula and infested shoots with total tree height (m) in current and subsequent years (ns = not statistically significant; ** = significant at P < 0.05)

Measurement year	Tree height in current year	Tree height in subsequent year	Tree height in current year	Tree height in subsequent year
	Number of hibernacula		*Number of infested shoots*	
1976	0.15 ns	0.18 ns	0.04 ns	0.07 ns
1977	0.22 **	0.23 **	0.30 **	0.34 **
1978	0.40 **	0.41 **	0.43 **	0.45 **
1979	0.08 ns	0.07 ns	0.04 ns	0.05 ns

A more interesting pattern of correlations emerged between number of hibernacula, infestation, and total tree height (table 2) and height growth (table 3). In 1976, the first year of *Acrobasis* evaluation, there was no statistical correlation ($r < 0.2$) between either measure of insect attack and growth variables. In 1977, there were low but significant correlations ($r > 0.2$) of hibernacula and infestation with total tree height. By 1978, both measures of insect attack were significantly correlated with total height and height growth. Furthermore, the magnitude of the correlation between total height and number of hibernacula doubled. However, by 1979 neither measure of *Acrobasis* infestation was correlated with total height or with height growth.

Such correlation patterns could result from the following circumstances: in 1976, when there was no correlation between infestation and tree size or growth, the

Table 3.—Correlations of number of hibernacula and infested shoots with tree growth (m) in current and subsequent years (ns = not statistically significant; ** = significant at $P < 0.05$)

Measurement year	Growth in current year	Growth in subsequent year	Growth in current year	Growth in subsequent year
	Number of hibernacula		*Number of infested shoots*	
1976	—	0.14 ns	—	0.08 ns
1977	0.10 ns	0.13 ns	0.18 **	0.23 **
1978	0.18 **	0.23 **	0.19 **	0.25 **
1979	0.08 ns	0.20 **	0.05 ns	0.04 ns

plantation was only 3 years old and all trees were in approximately the same size category. The initial infestation was small and the outbreak was distributed among trees of the same size class. By 1977 the outbreak was spreading to the larger trees as evidenced by the positive corelation with tree height; by 1978, positive correlations between infestation and both total height and height growth were present. By 1979, on the basis of average number of hibernacula per tree or mean number of infested twigs per tree, the infestation seemed to be declining. Furthermore, the remaining *Acrobasis* no longer preferred the larger trees but infested any size trees.

All statistically significant correlations between total height and insect attack were positive, suggesting that *Acrobasis* preferentially attacks larger trees once an infestation is established in a plantation (table 2). Furthermore, it appears that in 1977 and 1978 *Acrobasis* also attacked the faster growing trees (table 3). The implication is that, initially, *Acrobasis* infests the largest trees, those with the largest crowns; however, in subsequent years when most of the trees in the plantation are in larger size classes, insect attacks are of a more random nature.

The lack of negative correlations between infestation in a given year and growth in subsequent years was surprising. *Acrobasis* damage has been described as resembling frost damage where infested terminals die back. In a large infestation, negative correlations with growth in the following year might be expected. However, in infestations at this population level, negative correlations were not encountered. Instead, positive correlations imply that somehow infestations had little effect on growth and perhaps were even slightly stimulatory. Thus, it is likely that the overall infestation levels were not high enough to affect average growth rates.

By 1979, when the trees averaged 2.4 m in total height (table 1), infestation appeared to be subsiding. Subsequent surveys did not disclose significant infestations. Thus, we hypothesize that *Acrobasis* is a problem on young trees less than 2.5 m in height; stem form may be affected but growth rate is not. Alternatively, a buildup of populations of natural predators of *Acrobasis* may have resulted in a declining *Acrobasis* population; unfortunately, no effort was made to monitor these predators.

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