Chairman: Peter W. Garrett

LEAF FLUSH IN BLACK WALNUT AT SEVERAL MIDWEST LOCATIONS

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INTRODUCTION

Late spring frosts damage the tender new growth of black walnut trees, and the earliest trees to break dormancy are vulnerable for the longest period. Walnut trees growing in coves and low spots (frost pockets) are most vulnerable. If the terminal shoot is killed, one or more lateral buds at the base of the newly killed shoot commonly develop; generally, the result is a multiple-topped and/or crooked tree.

We established a study to determine the pattern of leaf flush for walnut trees from various geographic areas when grown at various locations. The information will be used to help select the "best" source of walnut for planting at various locations.

METHODS

Data on leaf flush were collected for trees in five black walnut plantations. Three tests were established in Illinois, Ohio, and Michigan in 1967 using 1-0 seedlings.[2] Each contains trees from 20-25 sources from throughout the walnut range (Table 1). Each planting consists of a randomized complete block design with six replicates of 4-tree plots.

Two tests were established in southern Illinois by direct seeding in 1970 (Table 1). An excellent bottomland site in Union County, Illinois, contains progeny from 82 open-pollinated parent trees from the central Mississippi Valley. A moderately productive upland site in Jackson County, Illinois, contains progeny from 57 of the same open-pollinated parent trees. The parent trees are assumed to be of average form and growth. Although we avoided poorly formed trees, no rigorous superior-tree selection was practiced. Each planting consists of a randomized complete block design with five replicates of 5-tree plots.

Flushing was recorded in 1969, 1970, and 1971 in the Alexander County, Illinois, test and in all other plantations in 1971. The trees were examined weekly from time of first leaf flush until all trees had flushed. Leaf flush was recorded as number of days after April 1 when the first leaf on each tree was 2.5 cm long. Data were collected on individual trees and averaged for each plot.

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[2] The author greatly appreciates the cooperation of Dr. Howard Kriebel, Dr. Bart Thielges, Dr. Jonathan Wright, and Mr. Walt Lemmien in establishing these studies and collecting the data.

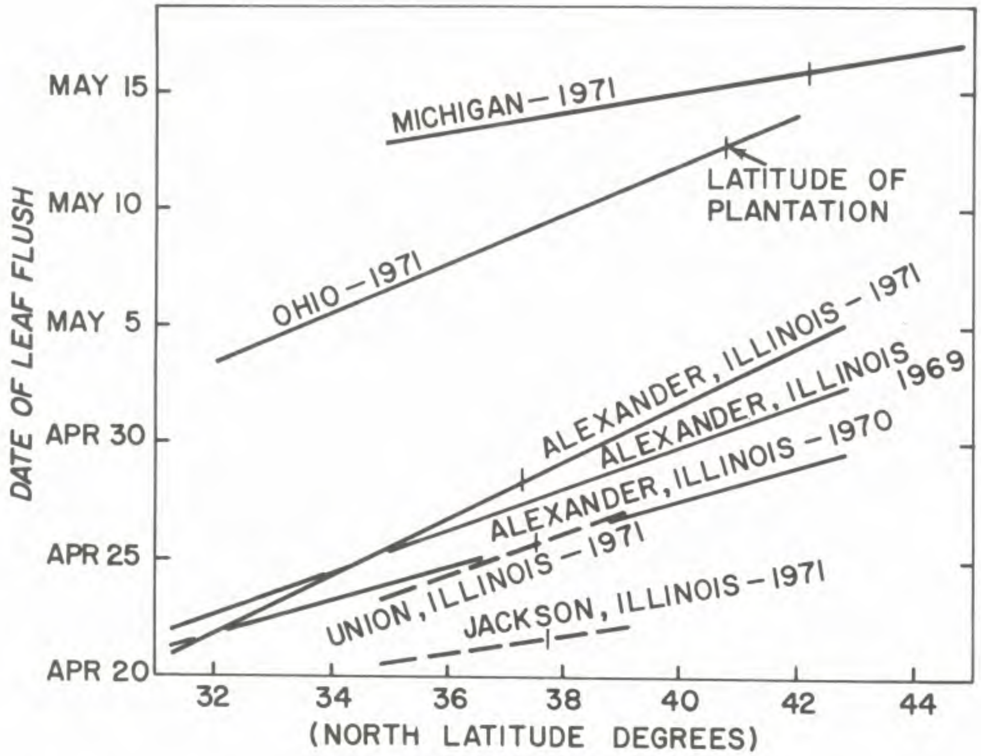

Figure 1.--Regression lines for date of leaf flush over latitude for black walnut trees from many sources at five locations.

Table 1.--Description, flushing date, and degree of determination for all plantations

State and County	Year established	No. of sources or families	Year of observation	Average flush date	Degree of determination
Illinois Alexander	1967[1]	20	1969	April 27	.42
Illinois Alexander	1967	20	1970	April 25	.52
Illinois Alexander	1967	20	1971	April 28	.59
Ohio Wayne	1967	24	1971	May 9	.70
Michigan Kalamazoo	1967	20	1971	May 15	.30
Illinois Union	1970[2]	82	1971	April 26	.17
Illinois Jackson	1970	57	1971	April 22	.16

[1] 1967 tests were established using 1-0 seedlings from stand collections.
[2] 1970 tests were established using germinating seed from open-pollinated individual tree collections.

RESULTS

Among Sources

In all five plantations, trees from the southern sources flushed earlier than trees from the northern sources (Fig. 1). On the average, flushing began 1 day earlier for every 85 miles south of the planting site that seed was collected. The regressions for date of leaf flush over latitude were highly significant in every plantation (Table 1). In 1971, trees from all sources in the Michigan plantation flushed in a relatively short time, whereas in Alexander County, Illinois, the duration of flushing was much longer. The shorter flushing time for trees from all sources at northern locations might be explained by the fact that the prolonged winter cold delayed flushing of trees from southern sources, as was found for red maple (Perry and Wang, 1960).[3] Another hypothesis is that there is a rapid heat accumulation in the spring in the northern soils. In the southern locations, where there is little snow, the soil is likely to warm more gradually in the spring, thereby magnifying seed source differences. Although either explanation sounds reasonable for the 1971 data from Alexander County, Illinois, Ohio, and Michigan, the wide variation in duration of flushing time for the Union and Jackson County, Illinois, plantations suggests that site and microclimatic differences also exert strong influences.

Winter chilling requirement and photoperiodic response seem to most reasonably explain why trees from southern sources flush earlier. Trees with minimum winter chilling and short photoperiod requirement would be the first to flush in the spring, and would be favored in areas where spring frosts are least common. In the north, early flushing is likely to be undesirable (from a survival and perpetuation standpoint) and, therefore, selected against. Female flowering and leaf flush are roughly simultaneous, so selection for or against early leaf flush is also likely to be selection for or against early flowering.

Among Plantation Locations

Among the three plantations established in 1967, trees in the southern plantations flushed first. Average 1971 flushing dates for the Illinois, Ohio, and Michigan plantations were April 28, May 9, and May 15, respectively. Trees from local sources in each plantation flushed about 2 days later than the average for the plantations. Therefore, we would expect flushing to be delayed about 4 days for every 100 miles to the north that a plantation is established.

Between Sites

In the tests established in 1970, the trees on the upland site flushed about 4 days earlier than the trees on the bottomland site. The plantations are about 15 miles apart (north and south), but the latitude effect could not

[3]Perry, T. O., and C. W. Wang. 1960. Genetic variation in the winter chilling requirement for date of dormancy break for Acer *rubrum.* Ecology 41: 790-794.

have caused the difference--particularly since the northern plantation flushed earlier. A possible explanation for earlier flushing on the upland site is soil moisture and temperature. The upland site was disced during the 1970 growing season leaving the soil more exposed than the bottomland soil and subject to more rapid warming in the spring. The bottomland site was also probably wetter due to drainage from the surrounding hills, and was subject to cold air accumulation. The trees in families on the upland site flushed in a short time, whereas on the bottomland site flushing took much longer. Rapid changes to warm and dry soil conditions in early spring probably tend to reduce the interfamily variation for date of leaf flush.

Trees from families that flushed early on the upland site also flushed early on the bottomland site. Analysis of variance using both sites showed family x site interactions to be nonsignificant. Although selection can apparently be made on either upland or bottomland sites, it will probably be more effective on bottomland sites where interfamily variation is greater.

Heritability for flushing date was .67 and .96 for the Jackson and Union County, Illinois, plantings--similar to the .67 value previously reported.[4] Heritability was computed using the following formula:

$$h^2 = \frac{4\sigma F^2}{\sigma F^2 + \sigma e^2}$$

where σF is family variance and σe is error variance. To eliminate seed source effects, flushing date means were adjusted to the latitude of the planting site before computing heritability. This procedure was necessary because many parent trees occurred as scattered individuals rather than in a stand.

Among Years

In one plantation (Alexander County, Illinois), the average flushing date varied only slightly among years. The maximum difference was 3 days--April 25 for 1970 and April 28 for 1971. Trees from sources that flushed early one year tended to do so the next. Rank correlation coefficients among years were highly significant, indicating no source x year interaction.

In the Alexander County, Illinois, test the percent of the variation in date of leaf flush explained by latitude (r) increased from t2 in 1969 to 59 in 1971. Perhaps the increase in the explainable variation is due to the gradual reduction of variation associated with establishment.

SUMMARY

In each of five black walnut plantations at three widely separated geographic areas, trees from southern sources flushed earlier than trees

[4] Bey, C. F., N. L. Hawker, and P. L. Roth. 1971. Variations in growth and form in young plantation black walnut trees. Proceedings 11th Southern Forest Tree Improvement Conference (In press).

from northern sources. Trees from sources that flushed early one year also flushed early the next, indicating no source x year interaction.

In tests established in 1967, trees in northern plantations flushed later than trees in the southern plantations--about 4 days later for every 100 miles to the north that the plantation was established. However, local microclimatic and environmental conditions can change the date of leaf flush within a geographic area. In a study established in 1970, on two sites about 15 miles apart, trees on the upland site flushed about 4 days earlier than those on the bottomland site. There was no family x site interaction for date of leaf flush. Trees from families that flushed early on the upland site also flushed early on the bottomland site.

Heritability for date of leaf flush was .67 and .96 for the two tests established in 1970. Additional studies are underway to determine how desirable leaf flush and growth characters can be selected simultaneously.