SEASONAL GROWTH PATTERN FOR FIVE SOURCES OF BLACK WALNUT

by

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To understand the effects of cultural treatments and weather on walnut growth, we must know when height growth and dry weight accumulation occur during the growing season. We also need to know how these growth patterns are affected by seed source and seed size. A better understanding of these variables will help in efficient scheduling of cultivation, fertilization, irrigation, and other cultural practices.

_METHODS

Germinating walnut seeds from five geographic sources (table 1) were planted in 5.4-liter (11/2 gallon) metal pots containing an equal mixture of soil, sand, and peat on May 18, 1966. Two seeds, each weighed before planting, were planted in each pot. The pots, placed in an open-grass-covered field at Ames, Iowa, were arranged in a randomized complete block design. Each of three blocks contained 40 pots—five sources and eight harvest dates for each source. One pot from each source was randomly selected from each block every 2 weeks for measurement of shoot length and ovendry weight of stems, leaves, and roots.

We used a regression approach to determine how growth of seedlings from the five sources changed with time. [2] Using data from other experiments [3] we set up models for expected growth response. We determined the *b* coefficients in the regression equations and tested for their significance. Our model assumed that the effects (whether negative or positive) of source, seed weight, and number of seedlings per pot should increase with time; thus time was a component of each factor in the regression equation. Since a few seedlings died, it was necessary to correct for differences due to number of seedlings per pot, as well as for seed size.

RESULTS AND DISCUSSION

Almost all height growth occurred during the first 6 weeks after germination (fig. 1). In contrast to height growth, most of the shoot (stem and leaf) and root dry matter accumulated after the first 6 weeks. Height growth increased until mid-July, shoot dry weight until mid-August, and root dry weight until mid-September. The decrease in shoot dry weight in late September was partially due to premature leaf drop and leaf chewing by grasshoppers (fig. 1). Also, there was some natural variation in seedlings randomly selected for measurement—those selected in September were slightly smaller in height and dry weight than those measured earlier.

The walnut tap roots grew rapidly and reached the bottom of the pots (21 cm.) early in the growing season. However, even when tap root extension was limited, total dry weight of roots increased until mid-September. Under natural conditions (unlimited soil volume), root elongation would probably continue until at least mid-September. Height growth also probably continues longer in nature than it did in the small pots. In a 3-year-old plantation in southern Illinois, 90 percent of total height growth was completed by July 10 in 1967, and by June 23 in 1968. In a different 4-year-old plantation in 1968, 90 percent was completed by July 11. [4] In these three examples, 90 percent of the height growth was completed in 8 to 10 weeks.

Active root growth in mid- and late summer suggests that it is necessary to control weeds throughout the growing season. The effects of fertilization and irrigation are likely to be more evident in dry weight accumulation than in height growth for any one year.

Seedlings from southern sources grew taller and accumulated more dry matter than those from northern sources. Dry weight of seedlings from the southern sources was greater early in the growing season and the weight difference between seedlings from northern and southern sources gradually increased with time (figs. 2-5 and table 2). Growth plotted over latitude shows a straight line relationship. This supports the conclusion that the geographic variation pattern for black walnut growth is continuous over latitude. [5] The seed sources differed more in seedling dry matter production than in seedling height growth. We would expect dry matter production, particularly root accumulation, to influence height growth in future years.

Almost all the *b* coefficients for the equations for height and dry weight were significant (table 2). The latitude x time coefficient was highly significant for all expressions of growth, indicating that latitude of seed source had an effect on growth that increased with time.

Height growth was not affected by the number of seedlings per pot but dry weight was less with two seedlings per pot than it was with one. Height growth and dry weight consistently increased with time as seed weight increased.

Although seedlings from the southern seed sources grew the most, their limited winter hardiness restricts their use very far north. Still, the increased growth potential of southern walnuts suggests the desirability of a testing and selection program designed to locate southern sources that are cold-hardy.

Table 1.–*Seed source location*

State	*County*	*Latitude* °*N*	*Longitude* °*W*
Iowa	Delaware	42.3	91.2
Iowa	Iowa	41.8	91.9
Illinois	McLean	40.3	89.2
Missouri	Reynolds	37.4	91.0
Arkansas	Stone	35.8	92.3

Table 2.–*Regression equations for height and dry weight growth*

y_H = Height $R^2 = .61$

y_T = Total dry weight $R^2 = .83$

y_R = Root dry weight $R^2 = .85$

y_S = Shoot dry weight $R^2 = .76$

T = Time.
L = Latitude (source).
SW = Seed weight.
N = Number of seedlings per pot.
* = Significantly different from 0 at .05 level.
** = Significantly different from 0 at .01 level.

$$y_H = 25.44 - 137.04^{**}[1/(T+1)^3] - .044^{**}(L \cdot T) + .045^{*}(SW \cdot T) + .157(N \cdot T)$$

$$y_T = 1.79 + 1.22(T) + 1.40^{**}(T^2) - .110^{**}(T^3) - .099^{**}(L \cdot T) + .054^{**}(SW \cdot T) - .568^{**}(N \cdot T)$$

$$y_R = 3.03 - 1.19(T) + 1.21^{**}(T^2) - .079^{**}(T^3) - .061^{**}(L \cdot T) + .030^{**}(SW \cdot T) - .372^{**}(N \cdot T)$$

$$y_S = 1.24 + 2.42^{*}(T) + .194\,(T^2) - .030^{*}(T^3) - .038^{**}(L \cdot T) + .024^{**}(SW \cdot T) - .196^{**}(N \cdot T)$$

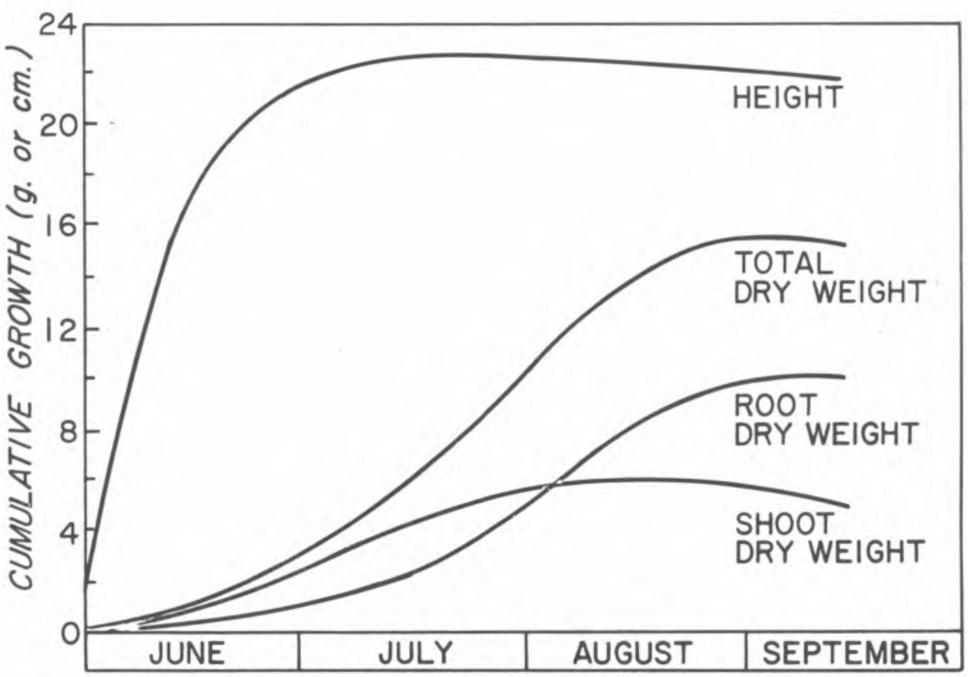

Figure 1.–Height and dry matter accumulation for walnut during first growing season.

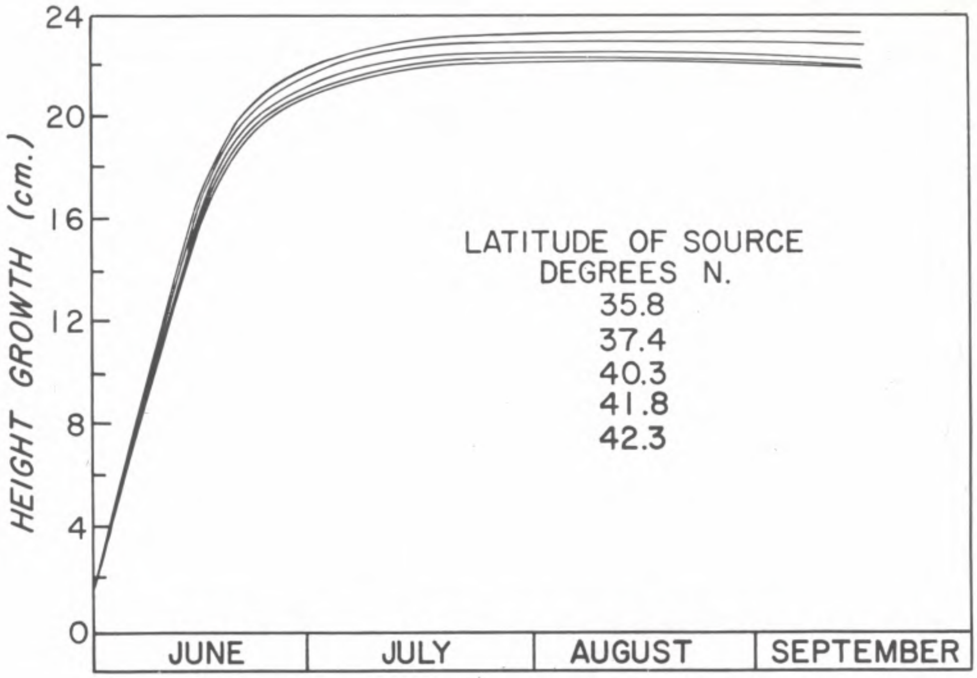

Figure 2.–Seedling height growth for five sources of walnut terminated by mid-July.

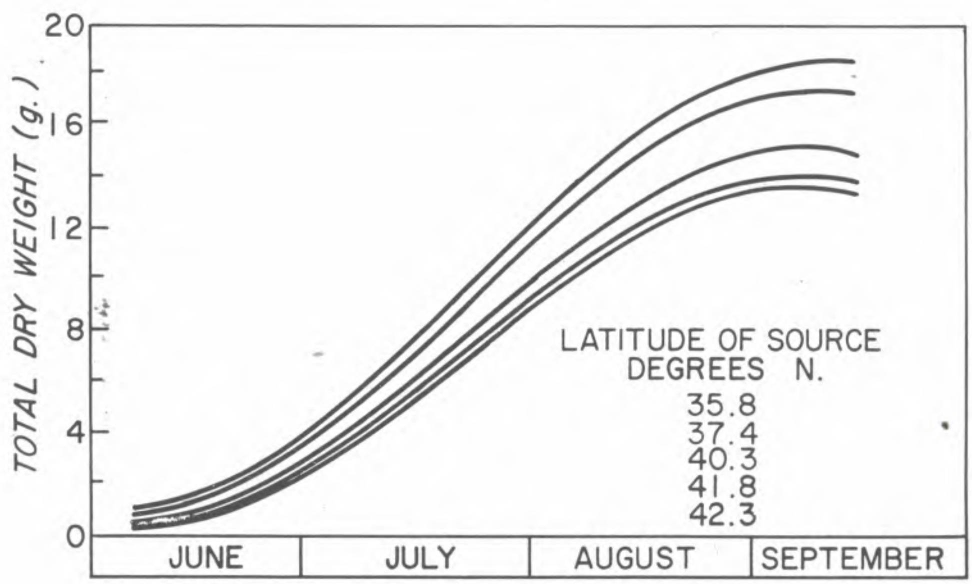

Figure 3.–Total dry weight increased until mid-September.

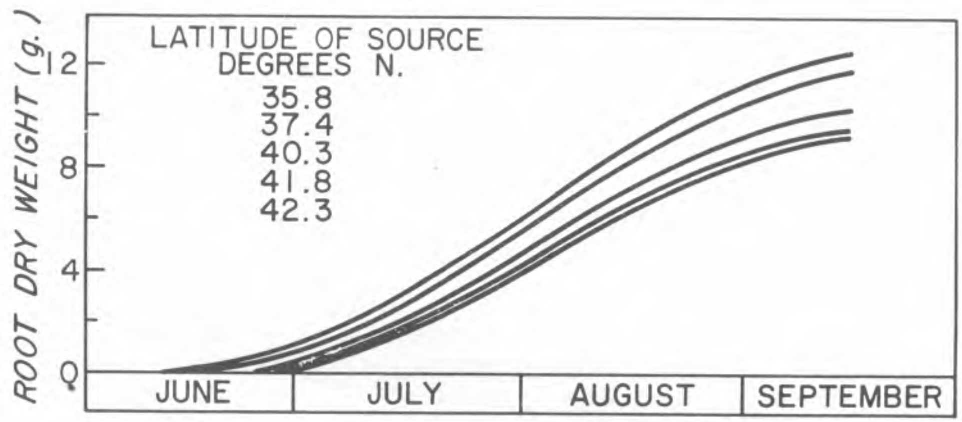

Figure 4.–Root dry weight increased until mid-September.

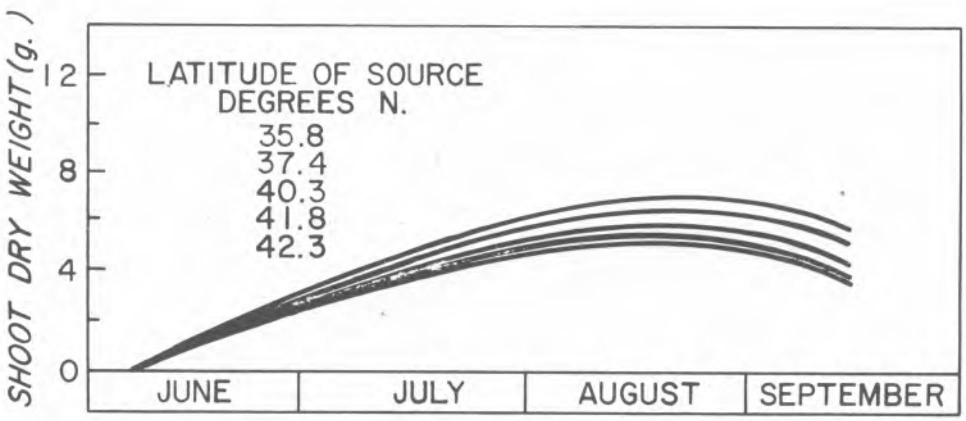

Figure 5.–Shoot dry weight increased until mid-August.

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2. The statistical assistance of Dr. David Jowett, Iowa State University Statistical Laboratory, is gratefully acknowledged.
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