Research Reports:

Establishment and Distribution of *Ailanthus altissima* in the Urban Environment[1]

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Abstract

An *Ailanthus altissima* (Miller) Swingle population in Ithaca, New York was found to be comprised of individuals from all size classes suggesting its continued potential for regeneration. Dispersal of seeds as intact panicles and strong root suckering contributed to its grouped formation in urban habitats. *Ailanthus* inhabited a range of urban sites that had a limited amount of exposed surface soil. The successful growth of *Ailanthus* into such sites was attributed to its simple rope-like lateral roots.

Index words: Tree-of-Heaven, urban habitats, root growth, seedlings, root suckers

Introduction

The urban landscape is a physically and chemically altered environment where street trees are subjected to stresses not encountered by their forested counterparts. Typically, city trees experience poor soil conditions, restricted rooting space, limited supplies of soil water, mechanical damage and high levels of reflected heat from built-up surfaces which can limit their survival (1, 6). In addressing the problem of early street tree mortality, one approach is to investigate those trees which naturally colonize and thrive despite these stresses. One such tree in the Northeastern United States is *Ailanthus altissima*.

The tenacious growth of *Ailanthus* in the urban landscape has been noted but actual data has not been obtained (7, 8). The intent of this project has been to investigate an *Ailanthus* population in its urban habitat and to examine those aspects of the tree's biology that have enabled it to adapt to the metropolitan landscape. To this end, the following questions were asked:

1. Is there an abundant and regenerating *Ailanthus* population in Ithaca, NY?
2. How is *Ailanthus* spatially distributed and is its spatialarrangement determined by peculiarities in the urbanmicroenvironment or by its reproductive strategy?

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3. What are the characteristics of its growing sites and how does *Ailanthus* exploit those sites?

Materials and Methods

The study site for this project was a 51 ha (126 Acre) section of Ithaca, New York (76° 30′, 42° 30′).

All *Ailanthus* individuals were mapped and categorized into size classes after trunk diameters at breast height (DBH) were taken.

Established *Ailanthus* individuals from 2 to 60 cm (0.8 to 24 in) tall were dug to distinguish root suckers from seedlings. Suckering shoots extended from a characteristic root which was elongating just under the soil surface. When a suckering shoot was growing from a large tree root it would snap easily, the base appearing white and succulent. Seedlings were easily excavated when small and larger individuals would not snap while being dug and pulled.

The following system was used to quantify the extent of *Ailanthus*' distribution in 'limited' and 'open' habitats. The rank "0" was used to indicate no growing space. The narrowest band of growing space was ranked "1" and termed a crack. The list progressed to rank "20", which described a tree grove. Rank "9" and all habitats below that were designated as limited. Rank "10" and above formed the open classes (10). A city block (Dryden Block) was selected to quantify the distribution of *Ailanthus*' in 'limited' and 'open' habitats. The block was paced in a grid of squares 6.7 m (22 ft) on each side. *Ailanthus* individuals within a one meter (3 ft) radius of each of the 520 corner points on the grid were counted. These corners of the grid were also classified in terms of habitat type (10).

A separate study comparing *Ailanthus* growth to that of *Acer platanoides* and *Liquidambar styraciflua* was made in a field plot in New York City. Seeds of *Ailanthus* were picked from one tree in Ithaca, New York (fall, 1981) and the following spring were stratified at 2.5°C (37° F) for two weeks prior to germination (9). *Liquidambar* seeds were stratified similarly (2). *Acer platanoides* seeds were picked after radicle emergence from under a mother tree in Ithaca, New York in April, 1982. All three were grown for approximately three months and 15 seedlings of each species were transplanted into a 31 × 46 cm (7 × 10 ft) New York City plot on June 9, 1982. During the first growing season, shoot lengths were measured. In October, 1983, after the second season, all trees were excavated and full measurements made. The trees were not watered or weeded during their two years of growth.

Results and Discussion

Abundance and Regeneration. A total of 2,215 established *Ailanthus* trees were counted in the sample area. The number of individuals in each size class revealed that the smallest *Ailanthus* formed 70%–75% of the total population (Fig. 1). In addition, the remaining population developed a full range of sizes up to 50+ cm (2 ft) DBH. Major similarities in the population curves of *Ailanthus* in both residential (CT) and business (DT) areas attested to its ability to regenerate and grow equally well in differing locations.

The large number of very small individuals and a complete series of size classes indicated that the present abundance of *Ailanthus* in Ithaca, New York would likely continue to exist. This was most probably due to its abundant seed and

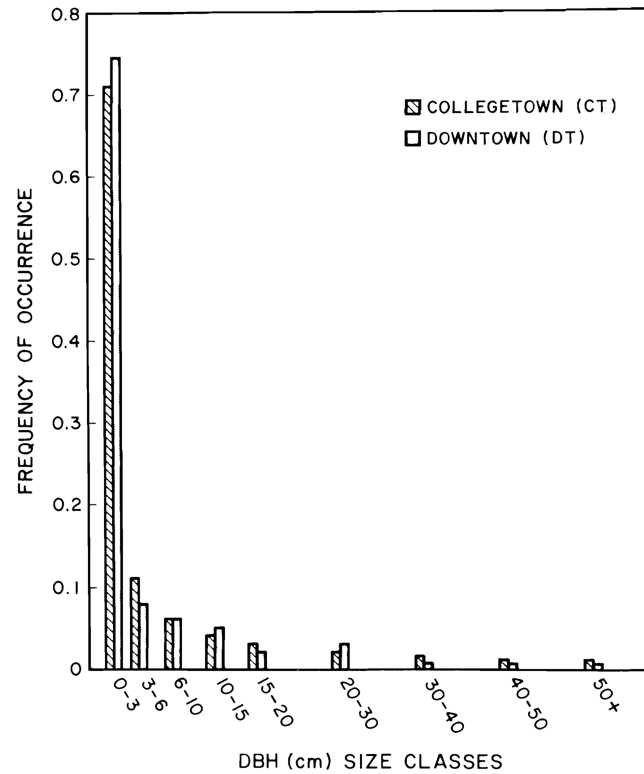

Fig. 1. Size Class Distribution: Size classes of *Ailanthus* individuals distributed in a residential (collegetown) and a business (downtown) district in Ithaca, New York.

effective dispersal mechanisms (5). It was also indicative that management practices by man such as cutting or the upheaval of sites for construction did not completely eliminate populations nor sites for its growth.

Some members of the small size class included stump sprouts and root suckers which were often formed when there was injury to the larger individual. A large decline in the next size class suggested a high mortality rate for newly germinating seedlings. This would be expected because many of the urban habitats such as drainage grates contained collected debris which did not support continued growth.

Spatial Arrangement. The spatial arrangement of the *Ailanthus* population, as plotted on a distribution map, exhibited a distinct clustering of the larger sized individuals (10). These clusters were found whether segregating city structures were present or not. To determine whether seedlings or root suckers contributed most to clump formation, a total of 1,912 one-year-old established individuals were excavated and counted. 42.5% were found to be seedlings and the remaining 57.5% were root suckers showing that both occurred in approximately equal numbers. It was observed that concentrated patches of seedlings resulted from seeds that fell as intact clusters. Seed clusters overwintering on trees would fall after senescence of the peduncle the following spring.

Habitat Colonization. The *Ailanthus* population in the entire sampled area was found growing in a diversity of urban habitats. The observed tendency of *Ailanthus* toward establishment in limited spaces was investigated using the Dryden block grid (Fig. 2). Out of 520 grid points, 313 were sites that could support plant growth (rank 1–20). Of

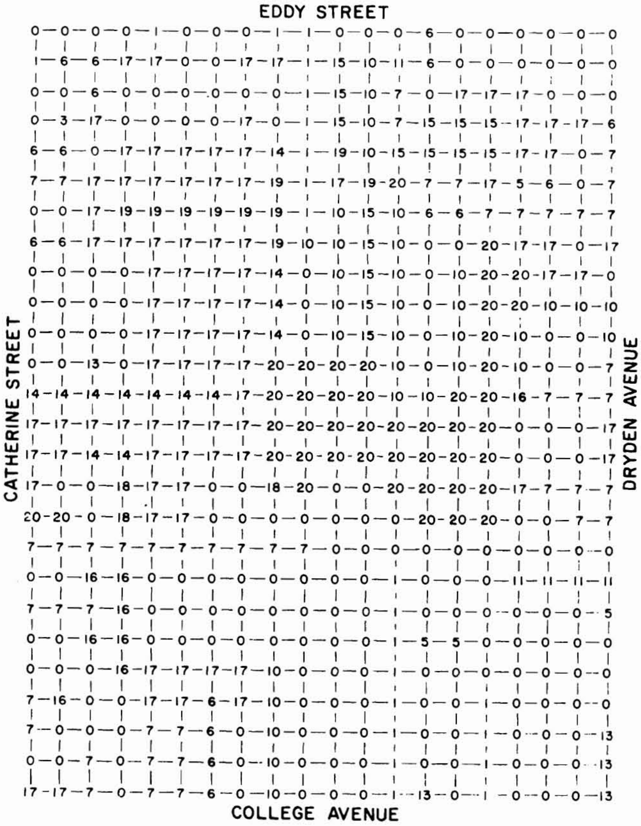

Fig. 2. Habitat types in the Dryden Block of Ithaca, New York. Corner grid points correspond to habitat ranks. Total area = 2.22 ha (5.5 Acre), Grid square = 6.7 m (22 ft) on each side.

these available sites, 89 were classified as limited (ranks 1–9) and 224 were open (ranks 10–20). There were 1,639 *Ailanthus* trees growing in this block, 870 of them inhabited those grid point areas designated as limited. The remaining 769 *Ailanthus* individuals grew in the areas designated as open. Therefore, more *Ailanthus* (53%) were counted in the limited spaces although the limited spaces comprised a significantly smaller portion (28%) of the grid than the open spaces. Thus, the visual observation that *Ailanthus* predominated in areas with limited topsoil was corroborated with these data.

New York City Plot. Data from the experimental plot in New York City gave an indication of *Ailanthus* growth as compared to that of *Acer platanoides* and *Liquidambar styraciflua* (Fig. 3).

When two-year-old seedlings were excavated, the tap roots of *Ailanthus* could not be totally sampled because of the depth and extent of growth. Although total dry weights of roots could not be assessed, the differences in the lateral root lengths between the three species were remarkable (Table 1). The average lateral root lengths of *Ailanthus* were three to four times as long as that of the other two species allowing *Ailanthus* roots to grow through a greater soil volume and into more variable soil environments. *Ailanthus* roots were coarse, unbranched and wide spreading, whereas *Acer platanoides* and *Liquidambar styraciflua* roots were fine, fibrous and confined to the area of the original planting hole. Maximum *Ailanthus* shoot lengths were as much as

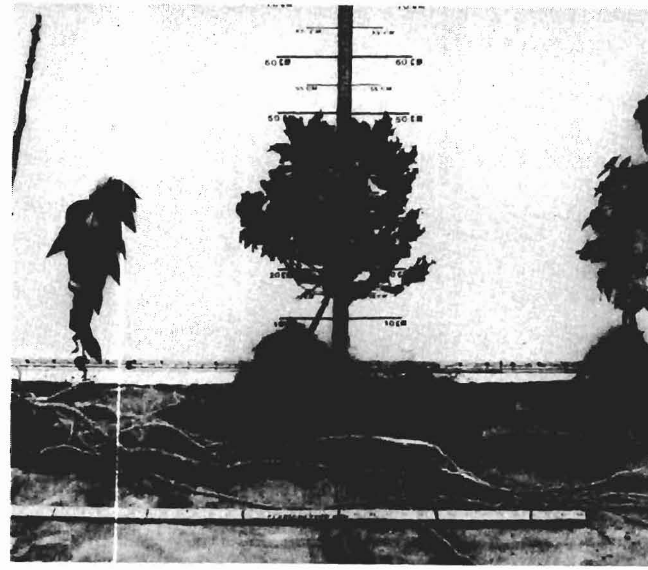

Fig. 3. Two-year-old seedlings excavated from a New York City plot showing comparative root growth. From left to right, *Ailanthus altissima*, *Acer platanoides*, *Liquidambar styraciflua*. (Excavated Oct. 1983).

one hundred centimeters taller than the maximum lengths for the other two species. (Table 1).

Ailanthus' root system appeared to possess distinctive advantages for growth in urban habitats. A parallel experiment on *Ailanthus*' growth in different soils with and without compaction, determined that during the first year of growth, allocation of resources was directed toward the root system (10). Once establishment was assured, shoot growth the following year could be extremely fast (8).

After investigating the ecology of *Ailanthus* in the city of Ithaca and a plot in New York City, the following ideas were proposed to explain its successful establishment in the urban environment.

The endurance of *Ailanthus* in the urban environment may be explained by its ability to reproduce equally well both sexually and vegetatively. Copious seeds (1 million per tree 12″ DBH) (8), and high mortality provide flexibility for genetic variation where parent trees must remain in situ in habitats often exposed to fluctuating conditions (4). Wide genetic variability among *Ailanthus* seeds has been confirmed (3). This, coupled with numerous seeds and effective dispersal insures the replenishing of urban sites which are often subject to erratic disturbances and spatial segregation.

The vegetative production of sprouts or roots suckers by *Ailanthus* is often found where injury to the parent plant has occurred. These vegetative offspring may also be sustained in a suppressed state while growing conditions are unfavorable. In the urban environment, an additional ad-

Table 1. Lateral root and shoot length (cm) of 2-year-old seedlings excavated from the New York City plot.

	Lateral Roots		Shoots	
	Average	Min-Max	Average•	Min-Max
Liquidambar styraciflua	23.8	2–46	51.0	12–77
Acer platanoides	33.2	14–66	36.1	23–49
Ailanthus altissima	114.4	53–200	82.2	31–172

vantage of connected root suckers is their collectively greater size which can more effectively occupy and compete for a site. Vegetative reproduction for *Ailanthus* insures the continued existence of the genetic individual as well as low risk mortality for its offsprings. Moreover, the colonization of *Ailanthus* was not restricted to open habitats where it had to compete with other plant species (10). Instead, it was able to establish in restricted areas where other plants could not sustain growth. The *Ailanthus* root system seemed most suited to such habitats. A few flexible lateral roots and a large tap root supporting the growth of *Ailanthus* may explain the successful growth of *Ailanthus* in the edge habitats that dominate our urban landscape.

Significance to the Nursery Industry

Several aspects of *Ailanthus* growth seem to have implications for managing trees in the urban environment. In the past, allowance for natural groupings have been discouraged; instead, trees are grown in an environment unlike the forest ecosystems of their origin and in a manner that subdues natural tendencies for vegetative sprouting and root suckering. In view of *Ailanthus* preferred clump formation, a new approach might prove worthwhile. It would mean enlarging single street planting sites to where grouped plantings would be possible. *Ailanthus* is also capable of surviving in edge habitats because it has a few, long, flexible lateral roots. Other trees bound for planting in the urban environment may be selected for similar root properties or be placed in areas conducive to lateral root growth.

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Sod Marketing at the Consumer Level[1]

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Abstract

Demand and consumption relationships for sod at the consumer level of the market were estimated. The price of sod, lot size and property value had significant impact on sod purchases. Consumers were responsive to sod price changes with a 1% change in price resulting in a 1.83% change in quantity demanded, other factors being held constant at mean levels. An evaluation of data for purchasers and nonpurchasers of sod indicated that income, house age, interest in landscaping and occupation had significant impact on purchases. Income elasticities for households having an annual income in excess of $31,000 were found to be elastic; that is, these households respond to income increases with larger purchases of sod. The market participation (entry-exit) phenomenon was credited with at least 70% of the total market adjustment by purchasers. These relationships emphasize the need for careful examination of advertising and pricing efforts of sod producing and marketing firms and also the potential growth of the industry as incomes and the general standard of living increase.

Index words: marketing, turfgrass-sod, income and price elasticities, consumer level modeling

Introduction

Commercial turfgrass-sod, hereafter referred to as sod, has received much attention in recent years as an alternative use for the land resource. This interest is exemplified by acreage and income expansion experienced in Alabama. Acreage expanded from 202 ha (500 A) in 1968 to about 2206 ha (5,450 A) in 1983 (4). Gross farm income has also increased from about $4.2 million wholesale in 1979, excluding delivery and installation charges, to about $7.1 million wholesale in 1983. With the enhanced economic importance of the industry has come the need for a better understanding of markets for and the marketing of sod.

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