NORWAY MAPLE DECLINE[1]

by Paul D. Manion

Abstract. Norway maple deterioration in urban areas is a major problem. An array of tree characteristics, site factors, climatic factors, and biotic factors are involved in the deterioration in a decline type syndrome.

Norway maple is one of the more abundant tree species growing in the Northeastern cities. In Syracuse, New York, it represents 42% of the older tree population. In Rochester, New York, it represents 56% and in Poughkeepsie, New York, it represents 71% of the population. Norway maple is also among the most frequently planted trees. In Syracuse, it represents 24% of the recently planted population (19).

Numerous cultivar selections for crown form and leaf characteristics are available. This European introduction has become a successful part of Northeastern urban forests. To some, it might be considered an ideal urban tree.

But Norway maples are deteriorating and dying at an alarming rate. Pirone (11) reported in 1959 that Norway maple accounted for 83.4% of the street tree mortality in New York and northern New Jersey. Recent correspondence with the Department of Recreation and Parks for Columbus, Ohio indicates that removal rate of Norway maple is rapidly increasing. Since 1972, they have noticed more deterioration of Norway maples than sugar maples. Hubbard & Morton (7) report severe crown dieback in 17% of the Norway maples in Ann Arbor, Michigan. In Syracuse, New York, we found 55% of the Norway maples with thinning crowns, and 14% with advanced crown dieback in 1976.

Why are the Norway maples deteriorating? On the basis of our own work and from what I can learn from the published literature, I would like to summarize my concepts in the nature and cause of the Norway maple decline problem. I should note in passing that there is a great deal more published literature on sugar maple decline than on Norway maple. There is amazingly little detailed work on Norway maple problems.

I would like to consider five possible factors contributing to the deterioration of Norway maple: 1) age, 2) girdling roots, 3) biotic agents of diseases, 4) abiotic or environmental agents, and 5) a combination of all of the above into a decline syndrome.

Before I get into the main body of this presentation, it would be appropriate to characterize decline symptoms for Norway maples. One of my graduate students, Jeanne Apple, sent a questionnaire to research people with interests in maple decline (1). She found some consistency but also some variation in what these people consider as symptoms characterizing decline. Using this information and a large base of street tree data that we have accumulated for Syracuse, New York, she developed a multiple regression model which accurately predicted decline classes based on three tree characteristics. One was crown shape, which quantifies the fraction of the crown missing on a scale of 1 to 8. A full crown was scored 1. A topped or dying tree with less than ¼ of the crown alive was scored 8. The second characteristic was crown density, scored 0 to 9. This was estimated by looking at the shadow or into the crown of the tree from below. A healthy Norway maple crown interrupts all the sunlight passing through, thereby, producing a total shadow or score 0. As the crown deteriorates, more light passes through. The amount of light is estimated as 10, 40, 60, or 90% and scored 1, 4, 6, or 9. The last characteristic is small dead limbs on the margin of the crown. These were scored 0, 1, 4, 6, or 9 as above corresponding to the fraction of the total marginal small branches affected.

Using these three characteristics, a model for predicting decline classes 1 to 5 (10) was derived.

Decline class = 0.84 + 0.10 × crown shape + 0.21 × crown density + 0.22 small dead limbs.

Other symptoms of decline such as large dead limbs, are important. Most are correlated to the above three and, therefore, do not contribute significantly to the model. Scorch, chlorosis, and

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other foliage symptoms are responses to recent or current environmental events and, therefore, are not good predictors of decline. They may be early indications of future decline though. Another of my graduate students, Barbara Schults (14), demonstrated a progression of symptoms from scorch to death of small dead limbs to death of large dead limbs.

Therefore, when referring to decline symptoms, I am primarily considering crown shape, crown density, and amount of small dead limbs on the margin of the crown. Large dead limbs and foliage symptoms are generally correlated to the above and may or may not be included.

Age. Norway maples have a life expectancy of 60 or 80 years and can grow up to 30 meters in height. Many of the large trees in our urban population are indeed reaching the upper limits of age and size. But, decline symptoms and mortality are not restricted to the large trees. In fact, in Syracuse, a negative correlation was found between tree size and decline symptoms (9). The larger trees are the more healthy.

Girdling roots. Girdling roots have been considered a major problem in Norway maples. Hubbard and Morton (7) found a significant correlation between girdling roots and decline symptoms. Although girdling roots were common in both the Syracuse and Rochester populations we studied, there was no correlation with decline symptoms. The prevalence of girdling roots is well documented. The role of girdling roots is unknown. Holmes (6) attempted to simulate girdling roots with iron straps and cables. He found that sugar, red and silver maples were killed within a few years by a girdling cable while Norway maple over grew and showed no adverse affects of girdling nine years later. Partial girdling with two metal straps and bolts did not result in death of any of the species tested. The importance of girdling roots to health of Norway maples is poorly understood and should be more thoroughly studied.

Biotic agents of disease. Verticillium wilt caused by *Verticillium dahliae*, is the best documented disease agent of Norway maple. Pirone (11) found that 13% of the mortality in Norway maple was due to Verticillium wilt. Norway maples were found to be the most susceptable trees of ten species tested by Smith and Neely (17). It is difficult to positively diagnose *V. dahliae*. Culturing is often difficult because the pathogen is not necessarily distributed throughout symptomed branches. The green streaking in the xylem which is a symptom of Verticillium may also be caused by *Phomopsis acerena* (12) and possibly other agents. Infection by *V. dahliae* does not necessarily induce death of Norway maples. Verticillium symptom development is enhanced by drought periods. We are presently evaluating Verticillium wilt resistance of half sib families of two-year-old Norway maple seedlings from the Syracuse and Rochester populations. Trees that develop symptoms and positively culture *V. dahliae* one year may look normal the next. I should add that there appears to be a high degree of heritability for resistance to Verticillium and, therefore, good prospects for developing resistant lines through breeding (3).

Pirone (11) found 22% of the dying Norway maples infected by *Ganoderma lucidum* and 7% infected with *Armillaria mellea*. In our survey work, we found indicators of heart rot in 25% of the Syracuse population but we did not characterize the specific cause of the rot (19). Although decay is very prominent in Norway maples due to the many wounds they receive, decay is generally not the cause of deterioration and death. A tree should be able to compartmentalize decay (15).

Norway maples have a number of canker diseases including *Cytospora, Eutypella,* and *Nectria cinnabarina*. In Syracuse, 2% of each *Eutypella* and *Nectria cinnabarina* cankers were found. We also found *Nectria cinnabarina* colonizing 53% of the young Norway maple trees one year after pruning and treating with wound dressing. Occasionally, branches were girdled by a canker developing in the stem but most of the young trees are totally recovered today. Decay caused by *Oxyporus populinus* (*Fomes connatus*) is often associated with Eutypella canker.

Bleeding canker caused by *Phytophthora cactorum* occurs occasionally but not enough to account for the extensive decline in Norway maple. I have personally only diagnosed one case of this disease.

Bacterial wetwood oozing was often evident from increment borer wounds. We collected 187 increment cores for studing recent growth of Norway maples.

Aphids commonly develop on Norway maples. There is a strong correlation between aphid colonization in the early summer and marginal scorch symptoms on leaves later (14). Sooty mold also develops on aphid infested trees.

We, at the College of Environmental Science and Forestry, in cooperation with Dr. Craig Hibben of the Brooklyn Botanical Garden, are assaying for viruses in urban trees. We have not yet characterized any of the viruses recovered from our Norway maple samples but in Europe, viruses have been reported for this species.

Abiotic or environmental agents. One of my graduate students, Barbara Schultz (14), studied the spatial and temporal distribution of trees showing decline symptoms. By recognizing the pattern of spread, we thought we would be in a better position to identify possible causal agents. Barbara found that trees with the symptoms of scorch, small dead limbs, or large dead limbs occurred in non-random linear aggregates. In other words, a tree with scorch, for example, was more likely to have trees on either side with the same symptoms than would be predicted by a random distribution of the symptom in the population. She also found that the trees with chlorosis occurred in clumps including both sides of the street. Although, most decline symptoms increased during the three years of study, some trees recovered. The only symptom that appeared to spread from one tree to its neighbors the next year was scorch. These findings generally suggest the importance of non-biotic localized site factors in producing decline symptoms except in the case of scorch.

De-icing salt is given primary importance for deterioration of sugar maples. Increased sodium levels in leaves has been documented (13). Kotheimer, *et al.*, (8) found that Norway maples tolerate levels of salt which produced injury on sugar maple and showed no adverse affects. A comparison of heavily salted main streets vs. lightly or non-salted streets in Syracuse showed no difference in the amount of deterioration of Norway maples (17).

During hot dry summers, a marginal necrosis on Norway maple leaves develops. This symptom called scorch is also very evident on trees with root injuries and is a symptom of salt damage. A similar symptom develops for herbicide and fluoride air pollution. As already mentioned, aphids may be associated with scorch symptoms, also. We should recognize from this example that a number of different agents may produce similar symptoms on Norway maples.

Dog urine has been suggested as a serious problem (11) particularly with trees growing in very restricted openings.

Frost cracks are common. Burke and Campana (2) suggest that cracking originating at branch crotches were significantly related to decline symptoms. Frost cracks or seams occurred on 20% of the Norway maples in Syracuse (19). Frost crack is common in nurseries and seems to be associated with a drop in winter temperature following a warm period (4, 5).

Root surface covering by asphalt and concrete induces soil aeration problems for trees (20). Another of my graduate students, Anne Mycek (9), found decline symptoms correlated with root surface covering. Hubbard and Morton (7) also report a relationship of pavement over roots and decline symptoms. Root disturbance and injuries to lower trunk and roots are also correlated to decline symptoms (7, 9). Crown disruption is associated with symptoms (9). Sidewalk replacement in Syracuse was a prominent factor inducing growth reduction and decline development (1). Trees growing in depressions which channel surface run-off water are declining (1).

Weather conditions, especially drought periods of two to three years are important contributors to decline of Norway maples. Jeanne Apple (1) found that growth of healthy trees closely parallels trends in moisture condition. The drought period of the 1960's reduced annual increment in both healthy and declining Norway maples. The declining trees never recovered normal growth.

Decline syndrome combination of the above factors. Although both the biotic and abiotic factors already enumerated are shown to be associated with decline symptoms, no single agent or condition is the primary cause of the Norway maple decline. Correlations, although significant, are generally low suggesting that more than one of the factors are involved.

If we accept the Sinclair (15) concept of decline as involving at least three factors, it may be possible to understand Norway maple decline. A decline should result from the interactions of long-term predisposing factors, short-term inciting factors and numerous long- and short-term contributing factors.

We are seeing the decline syndrome in the Syracuse Norway maple population. Increment core analysis of street and park trees demonstrated a predisposition of most of the trees during the 1960's because of the extended drought period. About half of the healthy looking Norway maples responded to the increased precipitation of the 1970's by increasing their annual increments. The other half of the healthy-looking trees, as well as the trees with decline symptoms, have continued to grow slower each year. Many of the most severely affected trees have been removed. Re-examination of the healthy-looking trees that are showing a declining growth trend determined that most of them are located near sidewalks renovated in the early 1970's or are in areas with water drainage problems (1).

The healthy-looking trees with declining growth trends are most likely in the early stages of decline. They have been exposed to the predisposing conditions of the 1960 drought and the inciting condition of a sidewalk renovation. They are prime candidates for contributing factors which will speed along the deterioration leading toward death or removal.

It would appear that age, girdling roots, biotic factors, and abiotic factors previously mentioned can be fitted into a decline syndrome. Age and girdling roots may be predisposing factors. The abiotic or environmental factors are generally inciting or, in some instances, predisposing factors. Most of the biotic agents are at best contributing factors which require a weakened host. They represent the number three punch.

If we accept this concept of the Norway maple decline, then the management options can be more clearly defined. We should first recognize that trees which are in the medium to late stages of decline, as recognized by the prevalence of contributing biotic factors and advanced crown symptoms, should be considered candidates for early removal. Money spent in sugar pill and cosmetic therapy at this stage does not provide long-term benefits. It is appropriate to identify those trees that have been predisposed by environmental circumstances. Every caution should be exercised to avoid inciting factors in these trees. For example, the value of new sidewalks should be considered in light of the potential effects on the trees. Predisposed, yet healthy-looking trees, can be detected through examining the growth trend for the past 20 years. A continuous decline trend over the 20-year period indicates a tree that has been affected by extended predisposing conditions or both predisposing and inciting conditions, Contributing factors such as weak pathogens are the next step in the sequence. Although we have no research evidence of the possible benefits of management for this type of tree, I would suggest that pruning and fertilization may reverse the decline trend if applied prior to the onset of crown symptoms. A declining growth trend for 4 to 6 years indicates a tree that has been predisposed but may recover if not exposed to additional predisposing or inciting factors.

In summary, Norway maples are affected by an array of plant, site, environmental, and biotic factors. None of the factors is individually capable of causing the extensive losses we see today.

Even *Verticillium dahliae*, which is probably the most aggressive of the destructive agents of Norway maple, develops most rapidly on trees predisposed by drought conditions. Management is best applied to the predisposing and inciting stages of a decline syndrome. The management of contributing factors is generally ineffective because the destruction of the tree is generally too far along to implement significant reversal of the deterioration trend.

The categorizing of dying Norway maples into a decline syndrome and the management suggestions I have given need to be field tested. I would hope that some of your might do just that.

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ABSTRACT

Smith, E.M. & C.H. Gilliam. 1980. **How and when to fertilize field-grown nursery stock.** Am. Nurseryman 151(1): 8, 68-69, 72-74.

Growth of nursery crops is affected by the physical and chemical properties of soils. Soil properties that should be considered before applying fertilizer include organic matter content, surface texture, drainage, and pH. It is usually necessary to apply fertilizer to planting sites prior to planting. If the needed mineral elements are applied to cover crops one or two years ahead of planting, the soil should be at a much more desirable fertility level at planting time. Definitely, a high phosphorus fertilizer, such as 0-46-0, 0-20-0, or 4-12-4, should be applied before planting nursery stock to provide a source of phosphorus for several years. Nitrogen fertilizers must be applied annually, due to leaching and crop use. To correct low phosphorus and potassium levels during preplanting, refer to the guidelines shown in Fig. 1. Ratios of 3-1-2, 3-1-1, 4-1-2, or 4-1-1 are best for plants that are already growing in nurseries. Consult Fig. 2 for suggested application postplanting rates of phorphorus and potassium for woody ornamentals. The recommended rates of fertilizing should be divided between the autumn and spring treatments.