Grafting White Barked Birches onto *Betula nigra*: Practice and Possibilities©

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INTRODUCTION

Industry experience indicates that for the most part cultivars of many white-barked birches are commonly grafted onto *Betula pendula,* European white birch. Examples such as *B. pendula* 'Youngii', *B. pendula* 'Laciniata', and *B. pendula* 'Tristis' grafted on to *B. pendula* seedlings are fairly common. When these graft combinations were grown in their native habitat or situations close to that, this should not present any particular problems. However, when these graft combinations are used in the United States where the climate considerations are significantly different they are frequently short lived and prone to insect and disease problems.

Dr. J.C. Raulston of North Carolina State University, Department of Horticulture, and I decided to look at this phenomenon and thought that by grafting white-barked birches onto a more appropriate rootstock a more adaptable plant could be obtained. We made a general supposition that if some of the stress factors that contributed to white bark birches were reduced in high heat areas they might be more adapted to a larger geographic area, including the southern portions of the U.S.A. Grafting is one way to achieve this, and the use of specific graft combinations to alleviate environmental stresses is not new. The grafting of *Citrus* species to *Poncirus trifoliata* to bring a small but significant degree of cold hardiness as well as inducing dwarfism is a long established practice (Barnes, personal observation; Dirr and Heuser, 1987). Other graft combinations are made with an emphasis on dwarfing, as in the East Malling rootstocks for apples, and establishing desirable cultivars on rootstocks tailored to unique soil conditions or make some selections more readily available, such as *Amelanchier* cultivars being grafted to *Crataegus* (Barnes, personal observation) and *Mespilus* to *Crataegus* (Barnes, 2005). As a consequence we decided on a number of white birch combinations with *B. nigra* as the understock of choice.

Betula nigra was picked as our understock because of its tolerance to high humidity and heat conditions, low requirements for chilling, particularly in the Deep South, and especially for *B. nigra*'s ability to tolerate water-saturated soils under very warm environments.

As a starting point to test the hypothesis of increased stress tolerance of white-barked birches *B. nigra* grafts had to be produced; they were not (and are still not) commercially available.

The purpose here is to outline what white-barked and some brown-barked birches functioned best on *B. nigra* at the initial propagation phase. Field and container testing was a further continuation of this project.

MATERIALS AND METHODS

Betula nigra seedlings were grown for 1 year in quart containers and were ready for grafting after that period with a stem diameter of 4–6 mm. Understocks were watered and fertilized regularly and had vigorous root systems at the time of grafting in mid-October.

Scion wood was chosen to match as much as possible the diameter of the understock. Scion wood length varied from 4–8 nodes. A linear measurement is not accurate, and proper sizing of scions given as quantities of nodes is more reliable. Scions were side-grafted onto the rootstocks and tied with rubber bands followed by a wrapping of Parafilm. Completed grafts were placed in a high humidity tent and allowed to knit for 21 days. Then they were gradually aerated to acclimate to normal greenhouse conditions. Ambient air temperatures were on the order of 25 °C during the day and 20 °C at night. Humidity though was kept very high by frequent syringing with water mist, with care being taken to not saturate the soil of the understock nor get water along the scions. The tent was vented starting at 21 days to allow for acclimation to a normal greenhouse environment. Completed grafts were allowed to go into winter in a cool greenhouse kept at 3 °C. After 90 days grafts were brought into a warm greenhouse and allowed to flush. A tally was made of the various graft combinations (Table 1).

Table 1. *Betula nigra* rootstock combinations.

Betula scions species	Bark color	Native origin	Take (%)
B. costata	white	China	100
B. ermanii	white	North eastern Asia	100
B. occidentalis (*fontinalis*)	brown	western U.S.A.	100
B. maximowicziana	brown/white	Japan	100
B. papyrifera	white	U.S.A., Canada, Greenland	100
B. pendula	white	north western Europe	100
B. pendula 'Youngii'	white	north western Europe weeping cultivar	100
B. platyphylla var. *japonica*	white	Japan	100
B. pubescens	white	Central Europe, Siberia	100
B. schmidtii	white	Japan, Korea, China	25
B. lenta subsp. *uber*	brown	U.S.A. (Virginia)	100

DISCUSSION

Table 1 details certain aspects of the grafting of a range of birches onto *B. nigra* rootstock. From a grafting perspective *B. nigra* seems to be an acceptable rootstock with 100% take on all the species grafted with the exception of *B. schmidtii*. Since all the conditions for the grafts were uniform the variation for such a poor take with *B. schmidtii* is most likely a physiological phenomenon or an environmental factor specific to *B. schmiditii*, but a specific explanation is not readily apparent.

Shortly after this work was begun we tragically lost our good friend, Dr. J.C. Raulston to a car accident and much of the work that he was conducting on this project was lost.

However, several grafts of *B. pendula* 'Youngii' and *B. utilis* var. *jacquemontii* from other work were kept at Lorax Farms and were planted out. After 12 years they are now mature and are setting seed. No graft incompatibility problems have been detected in that time; although the *B. jacquemontii* did die from borer attack. After the work of Barnes and Raulston, researchers at the North Carolina State Mountain Crops Research Center, Fletcher, North Carolina, did further work on studying graft combinations of white-barked birches on *B. nigra*. Dr. Tom Ranney and Research Extension Specialist, Dick Bir, looked at flood tolerance of a range of graft combinations (1994). One of their results was that white-barked birches grafted onto *B. nigra* showed superior growth and increased survival to induced flooding as compared to other rootstocks. They go onto say that *B. nigra* rootstocks may also be more tolerant to hypoxic soil conditions. While a scientific planting plan was not addressed, the *B. pendula* 'Youngii' grafts mentioned above were deliberately planted in soil conditions that exhibited frequent flooding and near hypoxic conditions. The sites were selected because other plant genera, *Cornus* and *Halesia*, succumbed to fall and winter rains and soil saturation with water with low oxygen levels; the *B. pendula* 'Youngii' grafts on *B. nigra* planted in the same area have not done so.

Further work by Ranney and Whitmann (1995) again looked at *B. platyphylla* var. *japonica* grafted onto *B. nigra* as well as four other white-barked birches. In this study *B. platyphylla* var. *japonica* grafted well onto *B. nigra* and in comparison to the other species of rootstocks in general had greater trunk diameters and tree height, except for *B. pendula* as a rootstock. However, frost cracks developed with the *B. nigra* rootstock combinations that did not occur with the other *Betula* species as rootstocks. Also the *B. nigra* rootstock grafts developed chlorosis due to high pH problems and iron deficiency brought on by the pH situation, which is a common condition with *B. nigra* itself when grown in soils with high pH. Their recommendation was to utilize *B. nigra* grafts for acid soils with care being taken to avoid alkaline conditions that might lead to the chlorosis problems.

In spite of these physiological conditions Ranney and Whitmann (1995) stipulated that *B. nigra* should be considered to be an appropriate rootstock for *B. platyphylla* var. *japonica*.

Another early supposition was that perhaps the resistance to bronze birch borer (*Agrilus anxius* Gory) could be conveyed by grafting onto *B. nigra*. *Betula nigra* is a birch known to be resistant to the harmful insect as it has little or no presence of rhododendrin, which when converted in the plant to the aglycone form becomes a chemical that attracts *Agrilus anxius* (Santamour, 1999). However subsequent work with grafts of *B. jacquemontii* on *B. nigra* that initially showed promise failed to remain immune to the bronze birch borer once the grafts reached maturity and started setting seed (Barnes, personnel observation). This suggests that the chemicals involved, rhododendrin and its aglycone, rhododendrol, are produced in the arboreal portions of the white birches and not in the root systems. Grafting then would have only a marginal affect on the rhododendrin production. However, the *B. pendula* 'Youngii' grafts listed above have been setting seed for a number of years, and they have remained free of bronze birch borer. One condition that may account for this is that the *B. nigra* graft combination affords a certain degree of tolerance to stress situations, which normally would weaken the tree and set it up for bronze birch borer infestation, which seems to be most likely the case.

Santamour (1999) suggests that rhododendrin, a natural component of many white-barked birches, as a result of senescence of leaf tissue, undergoes hydrolysis to rhododendrol, a known phytochemical that attracts the bronze birch borer. Although Santamour in his study did not mention any correlation with the presence of bronze birch borer and flowering of birches, casual observation over years of seed collecting by myself from white-barked birches indicates that there is more than circumstantial evidence to suggest that there is a direct relationship between the increasing age of the plants, the presence of flowers, and the infestation with bronze birch borer (Barnes, personal observation). Actually this goes in hand with some of Santamour's assessment of leaf senescence since flowering and the formation of flowers is derived from leaf tissue. Could it be that the same physiological factors that contribute to the hydrolysis of rhododendrin to rhododendrol are the same in flower formation and maturing as in leaf senescence? Could a quantitative analysis of leaf tissue show an increase in rhododendrol as a function of plant age and flowering and in turn give an indication of susceptibility to infestation by *Agribus anxius*. Shetlar (2000) contends that stress factors that contribute to leaf tissue degradation and senescence include heat stress, drought, flooding, and hypoxic soils thereby setting sensitive birches up for rapid attack by the bronze birch borer. By limiting the incidence of stress factors *B. nigra* grafts may be reducing the potential for borer infestation. It should be noted that in agreement with Santamour (1999) and Shetlar none of the *B. pendula* 'Youngii' grafts have exhibited abnormal leaf senescence and have remained borer free.

Specific recommendations from this work and that of Ranney et al. (1994, 1995) indicate that *B. nigra* should be an effective rootstock for many of the white-barked birches and the use of *B. nigra* as a rootstock contributes a range of positive attributes to the graft combination. The very good graft takes and the continued thriving of the *B. pendula* 'Youngii' indicates that using *B. nigra* as a rootstock for grafting other birches is a realistic possibility.

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