The Mysteries of Grafting and Some Forgotten Basics ©

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If you were to ask 10 ornamental plant propagators to reveal their recipes for propagating plants, you would probably get 10 different answers. Each would have his or her own way of doing things. Granted, there would be many similarities with common practices and procedures, but no two recipes would be exactly the same. Each propagator learns the basic skills, and then refines them based on their individual needs and challenges.

Propagation by grafting is no exception. Each grafter has a different recipe. There are many recipes, but no true mysteries in grafting plants — just that some procedures are unused or unknown to some propagators, but commonplace among others. There are differences among grafters based on who they learned the art from, where they are geographically located, what materials they have available to them to utilize, and of course, what plants they are working with. For the most part, all of these recipes "work." The goal of the grafter is to refine his or her recipe in order to optimize success given their specific goals and challenges. My experience has taught me that the majority of grafting problems arise from forgetting the basics, not necessarily from any mysteries and/or unlearned tricks. There are basics that apply to all grafting, and there are a few "tricks" to better success with certain plants. The basics, however, far outweigh any tricks when successful grafting is the objective. Here I will primarily address some grafting basics that are often overlooked or misunderstood and some "tricks," when utilized with a firm understanding of the basics, that I have learned to be beneficial for the plants with which I work.

When grafting ornamental plants, there are three primary areas of concern to address: (1) The rootstock — which will serve as the support system for the subsequent plant. (2) The stock plant, or perhaps more specifically, the scion; which will serve as the top portion on the new plant. (3) The actual procedure of grafting — combining the scion and rootstock. Of course, before care and aftercare are critical considerations in the process (see IPPS Combined Proceedings Volume 56, 2006), but for the sake of brevity, I am limiting this discussion to fine tuning one's recipe with a clearer understanding of the basics, and perhaps a few "tricks" I have learned over the years.

In short, the most important ingredients of the grafter's recipe is a vigorous and healthy rootstock; a vigorous and healthy stock plant; and good grafting technique. If the grafter keeps this in mind, and take steps to see that the basics are covered, success will be the result.

The rootstock begins the process. By far, the most important aspect of the rootstock is the overall health of this plant which will eventually serve as the foundation of the subsequent graft and the resulting plant. It must, of course, be compatible with the scion. The scion and rootstock must nearly always be of the same genus, and usually the same species. There are of course, exceptions, but the correct rootstock will minimize the possibility of graft incompatibility and failure, suckering, and over or undergrowth of the scion as compared to the rootstock. Some choices are better than others, and the grafter must keep in mind cost, availability, and the benefits and problems associated with one choice over another.

A vigorous rootstock will often forgive many technical mistakes made by the grafter. To ensure success, it must be free of disease and insect damage. A stressed or compromised rootstock will adversely affect the graft. At the least it will reduce the vigor of the subsequent plant. It can also cause the graft to fail if the defect is significant. Oddly enough, I find many grafters utilize poor rootstock in grafting. In this respect, the grafter must be a nurseryman first, then a grafter. Care must be taken in growing the rootstock well, just as any other plant in the nursery. Often rootstock is treated like a second-class citizen in the nursery. Growing the rootstock is often an afterthought, with very little planning and care taken in the care and health of the plant. This is where the "art" of grafting appears. The grafter must learn to plan ahead and grow the rootstock under optimum conditions to ensure the plant is not stressed. I strongly believe that an established seedling, rather than a bare-rooted one, will produce superior results when grafted. In my nursery, I pot up the rootstock 10 months, give or take, prior to grafting. I have learned what size seedling to shift up, so that after the following growing season, the plant is at the optimum size for grafting. Some seedling rootstocks will not be slowed down by transplanting and growing a season prior to grafting. Others will be stressed, and take the entire season to recover. This factor comes into play when selecting seedling sizes to pot up for grafting the following season. This takes planning, and from time to time, failure. In this respect, grafting is an art more so than a science. It takes experience, forethought, and the ability to adapt.

Vigor is also a two-edged sword. Too much vigor can lead to a pot-bound rootstock which in turn will likely have experienced stress during the growing season. This will adversely affect the success of the graft, and of course, contribute to root problems in the future.

Therefore, the propagator must diligently care for the rootstock in the nursery prior to grafting. This means adequate water, adequate fertilizer, adequate air circulation, and a keen eye on any disease or pest issues.

Another basic, but critical, concern in grafting is the scion. The scion is the cutting from the stock plant that will serve as the top portion of the graft and subsequent plant. Like the rootstock, the scion must be vigorous and healthy. A healthy scion can only come from a healthy and vigorous stock plant. The grower must ask the same questions he or she would of any plant used for propagation. Is it healthy? Is it vigorous? Is it or has it been under stress? Surprisingly often, I see grafters use inferior plants for stock. They may rely on plants in gardens, arboreta, or in their landscape. Often these plants have not been maintained for that purpose, and the scions obtained will be inferior. They may have received inconsistent irrigation. They may have disease or insect pressure, or perhaps they are aged and produce very little juvenile growth. Scions collected from these plants will be small, and will lack the vigorous flush seen with larger scions.

For consistent success, one must obtain scions from a vigorous stock plant. This means a plant that is maintained for that purpose. It must be free of stress. It must receive adequate water and be free of insects and disease. It must be pruned such that it will produce robust, juvenile shoots. This, in short, means that for successful grafting, it is best to maintain stock plants, ideally within the environment of the nursery itself. Here one has access to water, shade, winter protection, and pesticides if needed.

I have recently dedicated several cold frames for stock plants. After the infamous Easter freeze of April, 2007 in the southeast U.S., I chose to plant stock plants in the ground under an over-wintering structure. In that year, I experienced 3 days of subfreezing temperatures as low as 16 °F. Not unusual for the mountains of western North Carolina, however this event took place in April after 2 weeks of 80 °F weather. New growth on my stock plants was up to 12 inches long. Many plants were devastated, if not killed outright. Under this structure, I can provide winter protection from late freezes; offer shade with protection from sun, hail, and some insects; mitigate wind exposure; and provide irrigation. Since the plants are in the ground and not in pots, they are less prone to root-zone-temperature fluctuations, and in my estimation perform better than they would in pots. Since I prune them hard for cuttings each grafting season, vertical growth is reduced. I estimate this gives me 10–12 years or so of quality scion material before they will outgrow the structure and need to be removed and replaced.

From these vigorous stock plants, scions are cut. I usually cut all of the current season's growth, with the exception of the first set of buds. Scions should be dormant, or in the case of summer grafting, between flushes, with new buds formed at the base of the petiole. The graft union must heal prior to the scion breaking dormancy. If the scion breaks dormancy too early, there is no path for water and nutrients to move from the rootstock to the leaf buds. If the scion is dormant, it will not break bud before the union heals. The larger the scion is, the better the flush after grafting. This is because the scion is vigorous and healthy, and the larger scion must have a larger rootstock, which in turn is generally more vigorous and healthy.

One factor to consider; however, is that the larger portion of the cutting will be at the base, and the grafter must usually cut it into several individual scions. The larger scions will then have no terminal bud(s), which can be problematic after the graft when wishing to re-establish a leader in the plant. The smaller scion will have the terminal bud(s), but will not be as vigorous as the larger scions. This is a tradeoff, and becomes a judgment call for the grafter.

This is not the forum for a full discussion of grafting techniques, but I would like to offer a review of some of the basics and perhaps offer some tips with regard to the actual grafting process. Proper technique is a given in the grafting process. However, I have found that with healthy stock plants and rootstock, less than perfect technique will be forgiven. This is not to say that mediocre technique should be tolerated. It is best to work diligently to have all the variables in the grafters' favor.

First and foremost, is a sharp grafting knife. I have given many seminars and lectures where students brought their own knives. *Nearly always*, the knife is woefully dull. A sharp knife will make the cut easier and cleaner and offer better results. A ragged cut damages the cambium layer, which is crucial in healing or callusing. A dull knife is more likely to cause injury as well. It takes more effort to pull it through the scion, and too much effort can cause the knife to jerk or slip as it is pulled through the scion or rootstock, potentially causing injury.

Graft low, the lower the cut into the rootstock, the more cambium is exposed. The more cambium that is exposed the more surface area for contact between the cambium on the rootstock and the cambium on the scion. This allows for better callusing and a stronger graft union.

When cutting into the rootstock to insert the scion, make the cut between nodes. This gives a smooth area without obstacles. Make the cut to remove the top portion

of the rootstock above this node (or higher). This allows the graft union to "compartmentalize," so to speak. The tissue at the cut on the rootstock will die back to the closest node above the graft. This prevents desiccation going beyond the node and to the graft union. This "sap stool" will also pull excess moisture away from the union in the event the rootstock is overly hydrated. I have found that this simple step has dramatically increased my graft "take" or percentage. It will require a second cut back to the graft at a later time, but I have found this extra step rather quick, and the benefits greatly outweigh the extra effort.

Use the largest scion available from the current season's growth. The larger the scion, the larger the rootstock one can utilize. This will result in a more vigorous graft, and arguably a better plant.

If you only have access to very small scions, don't hesitate to go to second-year wood. Often on older plants the new growth is limited and inferior at best. I have found that my success with older wood, meaning second-year growth, is better than with tiny, possibly desiccated current year scions. When using second-year wood, it is often beneficial to use a hot callous pipe. This will heat the graft union while leaving the rootstock and top portion of the scion at the ambient temperature.

Healing will generally be rather quick, perhaps 7–10 days, and will promote callusing on older wood. This system is rather cumbersome, so it does not lend itself readily to production numbers, but it is useful with smaller quantities and/or difficult grafts.

With summer grafting, use mist whenever possible, and leave the foliage intact on the scion. When I learned to graft, I was taught to cut the leaf from the scion, while leaving the petiole. I soon found it unnecessary, and perhaps beneficial to leave the foliage intact. The graft was going under mist anyway, and the leaves could work to the plant's benefit, much like a rooted cutting.

If the rootstock lacks vigor or is too small, wait until next season to graft it. This is often difficult to do when one has orders and optimism, but I have found my take is poor with these rootstocks, and if it does take, this "wimpy" graft will not catch up until the following season. Then it becomes a liability in the nursery.

And now a few "tricks" I have learned over the years:

With *Acer,* it is advisable to stay within the same section of species. Most *Acer* are compatible with species within the same section, so the choice comes down to availability, cost, and perhaps cold or heat tolerance for a given graft. Some exceptions include grafting *Acer griseum* onto *Acer saccharum*. This has proven to be a long term (15–20 years) success, and can be a good way to propagate some of the newer selections ('Girards Selection' and 'Cinnamon Flake', *A. griseum* × *A. maximowiczianum* hybrids).

I have found it necessary to graft *A. circinatum* cultivars onto larger *A. palmatum* seedlings. *Acer circinatum* scions tends to over-grow the rootstock, but if larger rootstock is used, the difference seems to work itself out, forming a nice graft union and subsequent plant.

Acer pentaphyllum, sometimes considered the holy grail for maple enthusiasts has been difficult to propagate from cuttings or seed. I have found that *A. buergerianum* will work, however I do not know of the longevity of this combination. Some texts suggest *A. pseudoplatanus*, but plants I have observed display significant union problems with the scion overgrowing the rootstock.

A few years ago, Dr. Tom Ranney worked with *Betula* in hopes of finding a more adaptable, white-barked birch. One of the results of his work showed that *B. utilis* could be grafted successfully onto our native *B. nigra. Betula utilis* cultivars tend

to lanquish in the heat, humidity, and poor soils found in the Southeastern United States. *Betula nigra* thrives in this environment. This grafting combination allowed for an ornamental, white-bark birch to grow well under conditions normally problematic. I now have a *B.* 'Crimson Frost' (syn. *B. utilis var. jacquemontii* 'Crimson Frost') (*B. platyphylla* var. *szechuanica* × *B. pendula* 'Purpurea') growing just below a propagation house in a damp, if not wet, site. It is thriving.

When grafting *Cornus controversa* 'Variegata' and presumably other cultivars as well, it may be best to use second year wood. I struggled with this graft for several years, having inconsistent results. Upon observing a large, vigorous crop in a Japanese nursery several years ago, I mentioned this to the grower. He said he used second-year wood, and the results were evident. I followed his advice, and haven't had trouble since.

When grafting *Corylus avellana* cultivars, use *C. colurna* rootstock. *Corylus avellana* suckers excessively, and it is unrealistic to expect the homeowner to prune the suckers out year after year. *Corylus colurna* will not sucker. *Corylus collurna* tends to be pricey, but I believe the difference is insignificant compared to the problems associated with *C. avellana. Corylus colurna* has a corky texture, and does tend to overgrow the scion. This will produce an apparent graft union, but again, this downside does not outweigh the benefit. I believe this to be the lesser of two evils.

Another combination that I have used is *Fagus sylvatica* grafted onto our native *Fagus grandifolia.* In the southeast U.S., *F. grandifolia* tends to grow a little faster than *F. sylvatica.* I have observed 10- to 12-year old plants with this combination that show no signs of problems.

Hamamelis is another plant I have grafted for many years. All of the species (*H. mollis, H. virginiana, H. japonica,* and *H. vernalis*) are compatible with each other; however *H. virginiana* is the rootstock of choice. It suckers less than *H. vernalis* and is more readily available than *H. mollis* or *H. japonica.*

Witchhazels, often deservedly, have a reputation for suckering to excess. This is generally due to grafting onto *H. vernalis*, either knowingly or unknowingly. Many times I have purchased *H. virginiana* from reputable seedling growers, only to discover that many of the seedlings are in fact *H. vernalis*. I believe that witchhazels that sucker are probably grafted onto *H. vernalis.*

With that said, *Parrotia persica* presents itself as a choice for grafters of witchazels. This combination works, however, *P. persica* will tend to slow down the growth of the scion above. This may or may not be a problem, depending on the desired result. *Parrotia persica* will sucker initially, but will usually settle down, and not present too many problems. *Parrotia* roots readily or can be grown from seed to supply seedlings. This also lends itself to growing witchhazels on a standard for small trees. I have also seen *Fothergilla* grafted onto *P. persica* for the same effect. I have often wondered if some of the *Corylopsis* species could be grown in this fashion.

Experience is the best teacher, and talking with other grafters will expedite that process. While nearly every grafter will have some tricks and special techniques unique to his or her own operation and needs, these are secondary to achieving overall success. Adhering to the basics of grafting — growing vigorous and healthy rootstock, collecting vigorous and healthy scions, and utilizing good technique are by far the most critical aspect to successful grafting. The plant propagator who has mastered the basics, communicated with other grafters, and learned from his or her experience will enjoy success in grafting.