

Understanding Pruning

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By Brent Walston

Introduction

An IBC'er asks: "I want to have a better idea as to how a particular pruning action will affect the tree's development as well as how to use these predictors in styling." And Brent answers: The first thing you have to do is learn how trees grow. Read the article Principles of Plant Growth. It is drastically oversimplified, but it will get you going in the right direction. Then get a college text on Plant Physiology. I don't think it matters a whole lot which one, but wade through it. You might only get through one page at a time on the crapper in the morning, that's what I do, but read it at a rate that allows you to understand and apply what you are learning to actual growth in plants. There is another excellent article on plant physiology that all horticulture folk should read, although it is in a very tiresome style: Crown Pruning. I still find myself applying the principles of 'hormone pathways' outlined in this article. Following is an application of these physiological principles to bonsai pruning.

Plants as a System

The key to understanding pruning is to understand plants as a system. That is the beauty of the crown-pruning article. Removing a bud or a stem with buds on a plant does a whole lot more than just improve the looks of the plant. It makes changes all down the stem and right to the roots. Timing is also very important. You can shorten or lengthen resultant internode growth just by pruning at different times of the year. Much of this is explained in my Principles article. Think of plants in terms of storage and manufacturing. Plants store food (carbohydrates, not necessarily NPK) in two major ways, in the leaves and stems, and in the roots. These storage areas are fluid. Food moves between the two areas seasonally. In winter, most of the food storage is in the roots and the buds. As spring comes and the soil warms, storage begins to shift to the leaves. As the leaves begin to grow and photosynthesize, food is used and stored in the new growth and stems with the excess moved to the roots. Altering a plant by pruning it, either by top pruning or root pruning changes the storage and the hormone balance. The plant will try to recover, and this recovery effort is what you must understand if you want to manipulate growth principles into design parameters.

Removing top growth during the growing season when storage is high above, but low below, weakens a plant, and resultant internode growth and leaf size will be reduced. This is how we ramify and reduce leaf size. Overdo it and you can actually kill the plant. Removing top growth in winter when storage above is low and storage in the roots is high does two things. It pumps up the full storage capacity into a reduced plant causing fast coarse growth. And secondly, since this growth is going into few buds, all that growth is channeled into fewer shoots, causing enormous internode length and giant leaves. This is what happens after a trunk chop. Removing root storage in winter will have the opposite effect. LESS food will find its way into a full complement of buds, causing shorter internode length and smaller leaves. This is what happens in dormant root pruning and repotting. Removing roots during the growing season doesn't significantly upset the food balance, but it does upset the water uptake/transpiration balance and thus must be accompanied by top pruning, foliage reduction, or environmental change to keep from stressing the plant.

Hormones and Pathways

Hormone changes are no less important but not quite as obvious as food and water balance. The two most important for us are cytokinens, produced by the roots, and auxins, produced by the leaves and buds. These two hormones are in constant communication via the plants vascular pathways. Woody plants typically show strong growth at the branch tip (terminal bud) and the root tip. Strong terminal buds or terminal shoot growth (early in the season) produce a strong auxin signal that does two things. It suppresses bud break at all the buds behind it on the branch and stem. It also travels down the pathways to the root tip where it serves as a powerful growth regulator for the root tip. There it is destroyed. The strongly growing root tip produces cytokinen, which follows the same pathway back to the terminal bud, or shoot where it serves as a strong growth regulator. As you can see, this is a self-reinforcing cycle. Unaltered, this cycle produces a plant that grows strongly at the branch tips and at the ends of the roots.

Ramifications of this Cycle

Now for the ramifications of this cycle, especially if it is altered. First, unaltered, this cycle favors the terminal shoots and suppresses inner and lower growth. This is why trees lose inner and lower branches as they grow. As leaves photosynthesize, they feed themselves, their shoot and the local stem along the pathway. Excess production goes to the root. As long as this food and the auxin go to the root, this pathway will remain open and enhanced. Lower and inner leaves are shaded and produce less food and auxin. As long as the food production is in balance, the leaves will remain, new buds will be set, but shoot growth will be limited or absent. When production falls below balance, the auxin signal falls off and the roots will wall off this pathway. The leaves and buds along this pathway will eventually die from lack of water and nutrients from the roots.

Disrupting the Pathway

Now, alter the pathway. If you prune out the terminal bud and growth during the growing season, you do two things. You remove the food and auxin along this pathway to the roots. The response by the roots will be to wall off those pathways. Simultaneously, you are removing the strong auxin signal that has been keeping the buds behind the terminal bud suppressed. These buds are now released. They begin to grow, produce food and auxin, and the roots enhance the new pathway. Now we have secondary bud break. Ordinarily, only the bud following the terminal bud will break, but sometimes one, two or three other lower buds in the line will also break. But the first bud left at the end of the stem will feel the effect first and break first. It gets a jump on the other buds and soon begins to produce auxin just like the removed terminal bud and the suppression will begin again. Thus we have a limited number of buds breaking. The strongest response to terminal bud removal will occur in winter because there will be no bud break (and subsequent suppression) until soil temperatures begin to warm up and the roots begin to grow, signaling the buds to break into leaves. Thus winter pruning will produce the most bud break by interrupting apical dominance (terminal bud suppression) for the longest period. Summer pinching of the terminal bud will ordinarily give you only a two-bud break, resulting in good ramification. So winter is the time for most heaving pruning, spring is the time for ramification pruning.

Plants Shift Gears in Summer

Late summer is the time for no pruning. Mid to late summer is the time of the year that the plant changes gears. It has spent all spring growing leaves and stems. The terminal buds have continued to grow into new shoots each time they formed with little delay. This will often give you three or four internodes in a single season. The health of the plant, and the length of the season affect how much growth you get. By about mid season or a little later, a normally growing plant will stop opening new terminal buds. It retains its leaves and continues with food production, but in fact it is not growing (breaking buds or extending shoots). Now the cycle shifts back to the roots, which have spent all season busily pumping up water and nutrients to the top and only growing in response to the expanding shoots. As the terminal buds form or set as in bud set) there is an increased auxin signal to the roots, and the food, which had been fueling shoot growth, is pumped instead to the roots. This is a time of explosive root growth, and it will continue into the fall until soil temperatures begin to fall below about 50 to 60F. Even as the leaves begin to stop photosynthesizing in the fall, carbohydrates withdraw from the leaves and stems continue and the food is shifted to storage in the roots. The terminal buds retain enough food so that they only need water in the spring to break into leaf (a very handy little tidbit and another story about Bareroot Pruning).

Fall Root Growth and Pruning

This fall root growth is valuable knowledge for late summer and fall repotting (with some very important provisos, see the article on Fall Repotting). The phenomenon of bud set is also important to understand, because it is an important step in the process of developing a dormant state. When the terminal bud sets, it sends a very strong auxin signal; there is almost no chance for any new shoot growth anywhere on the plant. That's good because winter is coming and new growth would be burned off by early frost. You can interrupt bud set by removing the terminal bud by pruning. Thus if you prune in late summer or early fall, you can get new shoot growth from the newly released remaining buds. This is why nitrogen feeding in late summer or fall gets such a bad rap. It isn't the nitrogen (in most cases) that is fueling the new growth, it is the pruning. Nitrogen plays little role in releasing buds, but it plays a strong role in the expansion of new shoot growth. The common knowledge of the importance of feeding with 0-10-10 is a myth, although it does little harm.

And finally, these are the basic tools you need to analyze for yourself how, when, and where to prune. Take your time; it will take you several years to digest this experientially. I still have to think about it when I prune, that is, all the ramifications of what I am really doing. But that is changing, and I am beginning to incorporate these principles into my psyche so that I don't really have to analyze, but rather intuitively know what to do. This is the horticultural counterpart to the artistic principles. We can teach you about balance, proportion, the golden section, (and physiology), but you won't really be able to do decent bonsai until you own these principles and no longer have to think about them while working.