

How to Propagate Hybrid Hazelnuts by Mound Layering Lois Braun, Dept. of Agronomy and Plant Genetics, University of Minnesota

Mound layering (also called “stool bed layering”) is a very old method of producing new plants that are genetically identical to the parent plants. The problem with producing new plants from seeds is that they will not “breed true”. That is, their genes will be shuffled, or recombined from their parents. If you plant seeds from your best hazelnut bush, only 50% of the genes in the resulting seedlings will be from that outstanding mother bush. The other 50% will come from the paternal parent and, unless you have controlled pollination, you will not know what that parent is. Most likely the



paternal parent will be of inferior quality, and thus the offspring are likely to be inferior. A few might be superior, but most will not. Overall, your planting will be exceedingly variable, as variable as brothers and sisters in a human family, which makes managing it commercially unviable.

Vegetative propagation, also called cloning, is a way around this. In many woody crops, such as apples, this is done by grafting, but grafting does not work with multi-stemmed bushes such as hybrid hazelnuts that continuously produce new stems from the crown. Stem cutting propagation has also not proven reliable with current techniques.

The success of mound layering varies by variety. Some varieties do not root very well. However, most do, provided that the mother plant is strong and healthy.

Outline of Steps

1. Coppice bushes in the winter. That is, cut them down to the ground.
2. In late June or early July, when new stems are about as thick as a pencil:
 - a. Girdle stems by tying “twist-tie” wires around their bases, then
 - b. Apply a rooting compound to the stems just above the girdle.
3. Mound moist sawdust or a similar friable material to a depth of 9 to 12 inches around the stems.
4. Keep the sawdust moist throughout the growing season. Add more sawdust if it settles too much.
5. In the fall after dormancy, or the following spring before bud-break, dig up the new rooted shoots and transplant them to their new location.

Supplies needed:

For preparing the layers:

- A tool with which to cut the bushes down, such as heavy duty loppers, a chain saw, or a brush saw
- Knee pads, old tarps or quilts to make working on the ground more comfortable
- “Twist-tie” wires, of the type used to close food bags, approximately 3 inches long. Paper-covered wire twist-ties are better than plastic ones, which never decay and thus become litter.
- IBA, a rooting compound (sold as Dip N Grow, Hormodin, Root-One, or Rhizopon)
- Rubbing alcohol
- A small paint brush or cotton swab with which to apply hormone,
- Sawdust or similar light-weight moisture-holding material to mound up over plant, 5 to 10 five-gallon buckets per plant, depending on size of plant. Wet it thoroughly first.
- Tools for moving the sawdust, such as scoop shovels, buckets or wheelbarrows
- Optional: tarpaper or similar to form a ring around each plant to hold the sawdust in.

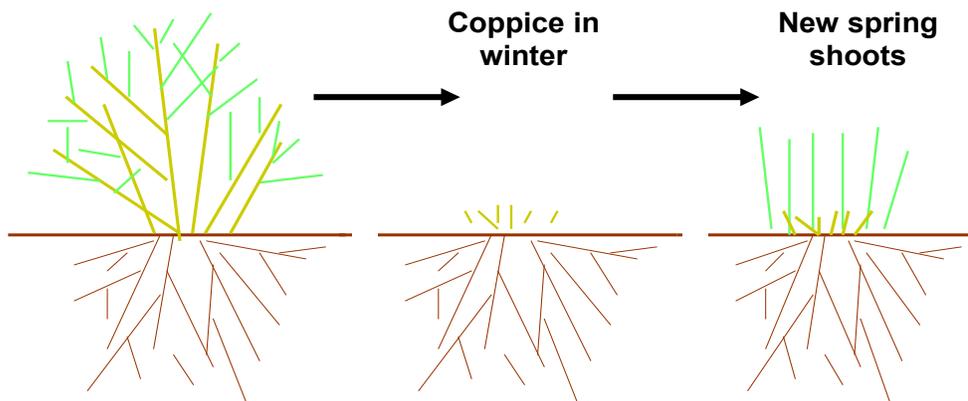
For digging the layers:

- Knee pads
- Pruners
- Fine-toothed pruning saws
- Buckets or large tubs for holding water
- Twine and flagging tape with a Sharpie pen for keeping track of the plant IDs
- Old heavy duty trash bags for carrying the layers

Before you start

Select your best hazelnut bush or bushes. These should be bushes that have performed well over several seasons, not just one. Ideally, they should be bushes in good health that are five years old or older. The larger the bush, the more likely it is to have a robust root system, which is essential for vigorous regrowth after coppicing. It may help to water and fertilize the bush the year prior to mound layering. Unless you know what nutrients might be limiting to growth, it would be best to use a balanced¹ slow-release fertilizer, such as Osmocote 15-9-12 plus micros. We fertilize with Osmocote immediately before preparing the layers, using one to two measuring cups per plant, depending on the size on the plant. Also, cut back competing vegetation to be sure the bush is not shaded.

Step 1: Coppicing



The first step is to cut the bush down to the ground, in the winter. This is called “coppicing”. This will stimulate the plant to send up new tender shoots in the spring each of which will become a new plant. Coppicing can be done any time that the bush is dormant, when most of the nutrients and energy of the plant are stored underground in the roots. You can still coppice in early spring, after buds have begun to break, but if you do it this late repetitively, you will weaken the plant.

Heavy duty pruning loppers work well for coppicing if you are doing only one or two plants, but if you are doing more than a few, a chain saw or brush saw will make the job much easier. Cutting bushes down with a chain saw is easiest to do with two people. One person ties a rope around each bush and pulls the branches away from the other person, who has the chainsaw, to keep the branches from falling on the chain saw operator and to keep them from binding. Tying the rope into a noose, then using a carabiner to fasten and unfasten it quickly, makes the job even easier.

Try to cut the branches off as close to the ground as you can, because any stumps left above ground level, will make it difficult to harvest the layers without tearing their roots. Try also to make the cuts clean; otherwise the sharp stumps may be a hazard for your hands when you apply the twist-ties and the rooting compound.

If you like, you can leave one or two “nurse” branches uncoppiced, to feed the plant’s root system the following year. This is a good idea if you plan to mound layer the same plant for several years in a row, but if you only plan to do it for one year, it is not necessary. Alternatively, you can coppice

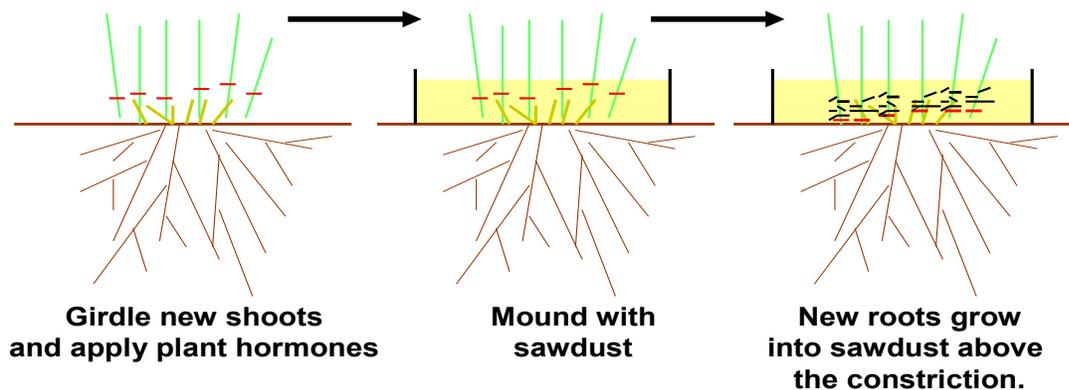
¹ A balanced fertilizer has a ratio close to 5-3-4, the proportions in which most species of plants need N, P, and K. This makes 15-9-12 a more “balanced” fertilizer than 10-10-10.

the entire bush, but designate one or two vigorous stems to grow up to become nurse stems by leaving the girdles off them.

Finally, cut back any neighboring bushes that may shade the plant you are mound layering, because shade can significantly reduce rooting. If these neighboring plants are also hazelnuts, be careful not to mistake the suckers emerging from them for suckers from the plant you are trying to layer!

As the suckers regrow, be sure to keep them protected from anything that might like to nibble on them. Deer and rabbits seem to prefer young tender plant tissues, and these new suckers will be the most tender of all. Even though hazelnuts reputedly taste bad to wildlife, these young new shoots appear not to have very high levels of the compounds that inhibit grazing. If you find that the shoots have been grazed it is likely that layering will not be very successful. Chicken wire fencing or deer repellants are both effective.

Step 2: Girdling and Applying Hormone



In early summer, when a good number of stems are about pencil-thickness ($\frac{3}{8}$ to $\frac{1}{2}$ inch thick) and 15 to 25 inches tall, it is time to girdle and apply rooting hormones to them. The window for doing this varies from season to season, but in the Upper Midwest, it is generally from the end of June through mid-July. Stems should be mature enough that they can withstand having a twist-tie wrapped around their bases without breaking, but they should still be greenish in color because they need to be juvenile in order to root. As the season progresses the stems develop a tougher and browner exterior layer, which seems to impede the emergence of roots.

The first steps are to remove all the leaves on the bottom nine inches of the stems--because they get in the way of seeing what you are doing and they will be buried in the sawdust anyway--and to thin the stems to reduce competition between them. Stems should be spaced far enough apart that you can easily get your hands between them to apply the girdles. Remove all stems that are thinner than a quarter inch and shorter than about 12 inches. Stems that are too short will be completely buried by sawdust and are not likely to survive anyway. The importance of thinning cannot be overemphasized, because competition between stems will reduce the vigor of all of them, resulting in stems that are too weakly rooted to be viable and wasting your effort.

If you did not leave nurse stems when you coppiced the bush, now is the time to select new stems to become the new nurse stems. Select two or three of the biggest and healthiest stems that are in a location where they will not get in the way of digging the rooted stems at the end of the season. It

is best to select stems towards the north side, where they will not shade the suckers in future years. Mark them at the top with flagging ribbon so you can identify them at the end of the season.

The next step is to girdle the stems by wrapping a “twist-tie” wire around the base of each one. The wires should be snug, but do not need to be tight, because as the stems grow through the season they will grow into the wire and girdle themselves. If you twist the wires too tightly, you run the risk of breaking the stems.

Putting on the twist-ties is the most tedious part of layering, because it has to be done at ground level. We have found that lying on one’s stomach, perhaps on top of a tarp or old blanket, and propping oneself up on one’s elbows is a moderately comfortable way of doing it for a while, though no posture is comfortable for long periods.

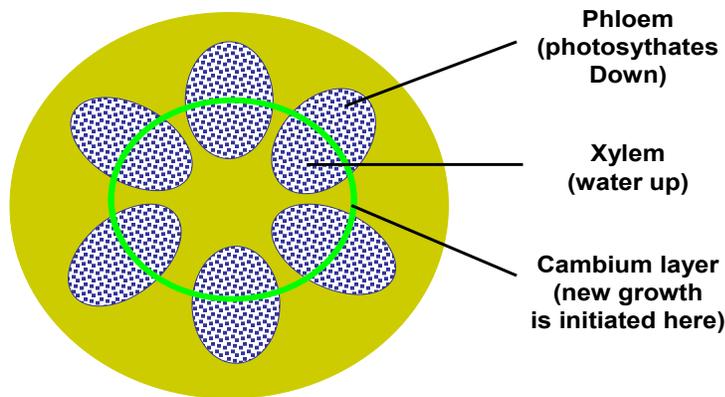
We used to recommend tying the wires as close to the ground as possible. However, doing so means that sometimes the new roots grow into the ground, making it very difficult to dig them without damaging them, especially if the soil is clayey. If landscape fabric has been used, and roots grow into them, it is nearly impossible to get them out intact. Therefore, we now recommend tying the wire 1 ½ inches or so above ground level to keep the roots out of the clay or fabric, though this requires that the sawdust be mounded higher. This will also leave more space to get under the roots with a saw at digging time.



The next step is to apply rooting compound to the stems. We have found that 2,000 ppm (2 g per Liter or ¼ oz. per gallon) K-IBA in a 1:1 solution of rubbing alcohol and water is best. Paint it onto stems in a one-inch band just above the girdle, using a paint brush or Q-tip. Alternatively, the rooting powders sold at garden centers (Dip N Grow, Hormodin, Root-One, or Rhizopon) can be mixed with a small amount of water to make a paste that sticks onto the stems. If applying hormone as a paste, use the 8,000 ppm powder, as listed for “hard-to-root” plants, because it seems that absorption is not as good with water as with ethanol. Another option might be IBA in a gel, but we have not tried it. We have found that concentrations higher than 2,000 ppm in ethanol or 8,000 ppm in talc resulted in excessively profuse but weak roots. We also found that spraying a water-soluble formulation (Hortex®) over the leaves was not as effective and stressed the plants.

Why does girdling promote adventitious² rooting? Girdling constricts the flow of photosynthates (sugar compounds produced in the leaves) down the stems to the roots but does not constrict the flow of water from the roots to the leaves. That is because the xylem, which are the capillaries in which water is transported upwards in plants, are located towards the interior of the stems and are not constricted by the girdle, unless it is too tight, in which case the whole stem will be killed. By contrast, the phloem, the capillaries in which photosynthates are transported downwards in plants, are located towards the outside of the stems, and thus are constricted by the girdle. Normally, photosynthates are transported in the phloem to the root system, to supply it with the building blocks and energy for growing more roots, as well as for winter storage. However, when the phloem is blocked by girdling, the photosynthates are put to use instead at the point where they were stopped, right above the girdle, to produce new roots there.

Cross-Section of a Stem



A second reason why girdling promotes rooting is that the natural plant hormone auxin, which promotes rooting, is normally produced in the apical buds of stems and is transported down stems to the roots. When its passage to the roots is impeded by the girdle, auxin accumulates right above the girdle, stimulating the stems to grow roots right there. A third reason is that girdling may injure the stem's cambium layer, which is where new growth is initiated. Injury to the cambium often stimulates plants to alter their growth, from stem growth to root growth. Indeed, we found that injuring hazelnut stems instead of girdling them also promotes rooting, though not as effectively as girdling.

The location of the xylem on the interior to the stems, relative to the phloem, also explains why girdled shoots can stay healthy and vigorous all season: they are still able to get needed moisture and nutrients from the mother plant's root system through the unimpeded xylem. However, because the reverse flow, of photosynthates from leaves to the mother plant's root system through the phloem, is impeded, girdling all stems on a plant will starve the mother plant and if done too many years in a row will weaken it beyond recovery. That is why we leave a few un-girdled nurse stems to feed the mother plant root system.

² Adventitious roots are roots that arise from any point other than the plant crown or root axis, such as the prop roots on corn, or the aerial roots on a banyan tree. The roots that emerge from stem cuttings of houseplants, placed in a glass of water, are adventitious roots.

Step 3: Constructing the Mound

After all stems have been prepared, the next step is to mound sawdust, or an alternative rooting medium, around the stems for adventitious roots to grow into. Other lightweight friable materials, like peat moss, rice hulls, wheat chaff, vermiculite, or a mix of these may be used instead of sawdust. The substance must be able to retain moisture without becoming waterlogged, because root growth requires both moisture and oxygen. Substances that are heavy or which cake, such as compost, soil, or sand, are likely to break stems and will make it difficult to dig the rooted stems out at the end of the season. Conversely, pure perlite is likely to dry out too much, though it might work in a mixture. The rooting material may be applied dry, and watered immediately afterwards, though we have found that it is easier and more effective to drench it with water before applying it. Some materials, such as sawdust and peat moss, become hydrophobic when they are completely dry; these might need to be soaked in water to wet them thoroughly first.

The quantity of material needed will vary by the size of the mother plant. The largest plants might need a quarter of a cubic yard or more.

To apply the rooting medium, we pile it on the outside of the bush, so as not to bury any stems, then scoop it into the interior with our hands, making sure that all stems are evenly surrounded by rooting medium. The objective is to cover the bases of the stems as deeply as possible—six inches or more-- while keeping at least five inches of stem above the level of the sawdust. If the sawdust is too shallow, it will not stay moist enough for optimum rooting. Roots will not grow into a dry medium. Since the sawdust will settle, more would be even better, except you don't want to completely bury the stems, which need their leaves in the sun for photosynthesis. The solution is to add more sawdust in the middle of the season, after the first application has settled and the stems have grown taller. We have found adding more sawdust mid-season greatly improves rooting success.

If you are short of suitable rooting media, a ring of tarpaper or something similar, to hold the medium in place around the plant, can be helpful. Ten- to twelve-inch-high rings can be constructed out of strips of tarpaper, Tyvec or flexible plastic sheeting, such as is used to make tree tubes. The width of the strip will vary according to the size of the plant.

Tarpaper is cheapest, but only lasts for one season. Because it is black, the sawdust adjacent to it heats up and dries out the faster, inhibiting rooting close to it. So, if you use tarpaper be sure to place it at least three

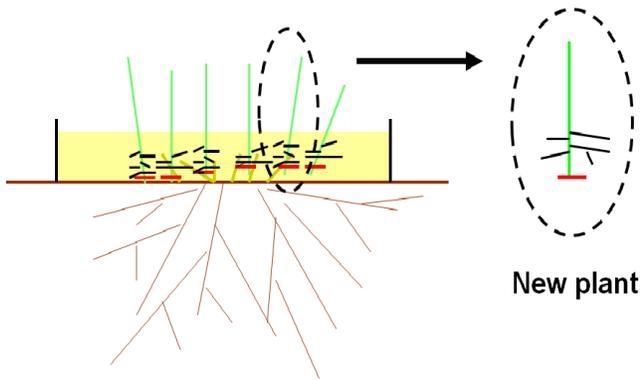
inches outside of the outer-most stem, and to water the sawdust more frequently. Tyvec and flexible plastic sheeting are much more expensive but can be reused. Tyvec is not stiff enough to stand up on its own while filling so it must be supported by stakes. Overall, we have found that using no ring at all is simpler to implement, and less expensive, assuming an abundant inexpensive source of sawdust or other rooting medium. Just pile it high enough and wide enough to compensate for settling and slumping due to heavy rain and plan to add more mid-season.

Finally, make sure that the rooting medium in the rooting zone stays moist for the duration of the season. This can make the difference between success and failure!



A newly constructed mound layer using tarpaper to hold in the sawdust.

Step 5: Harvesting Rooted Layers



Timing. Rooted layers may be harvested in either the fall or the spring, as long as the stems are dormant at the time of harvest. In the fall, the leaves do not have to have completely fallen, but the abscission layer between the leaves and the stems needs to have formed. This usually occurs in mid-October in the Upper Midwest. It would be best to harvest them early enough to transplant them into their new location early enough that the roots can grow about a month before the soil freezes, though we have been successful with transplants in early November. In the Upper Midwest, the window between when the stem goes dormant and the soil freezes may be very short. Therefore, it may be easier to wait until spring, though the window between when the soil is dry enough to plant and before bud break which may begin in mid-April may also be short.

Getting the layers out of the ground. To harvest, gently pull the sawdust or other medium away from the stems with your hands, and carefully work the new roots free. By pulling gently upwards or sideways on the stems, you may be able to snap them off where the girdle has weakened them. If not, carefully cut the stem below the mass of roots. Be careful to avoid pulling the roots out of heavy sawdust, which can strip off the root sheaths. Work quickly to avoid letting the roots dry out, placing the newly harvested rooted layers directly into a tub of water or keeping them covered with a moist material, such as sawdust taken from the mound. If roots from adjacent plants are entwined, simply harvest them as a mass and separate them later in a large basin of water.



The roots grow right above the constriction. (Note that the black root sheaths on this layer are dead. They are probably the result of using too high a concentration of IBA.)



This stem snapped off right above the girdle, where the constriction weakened the stem. Note the callous tissue right above the girdle. (These roots are a lot healthier than the ones to the left.)

We have been experimenting with less strenuous methods of harvesting layers. Commercially, layers are cut under the sawdust with a large rotary saw pulled behind a tractor, but we need something intermediate in scale. We tried various power tools, including chain saws, hedge trimmers, and reciprocating saws, but they either were jammed by sawdust or didn't have enough power to move under the weight of the sawdust, or both. We finally found several hand tools that make the process somewhat less tedious. A variety of sizes of hand pruning saws and rice blades



Tools for harvesting layers. From left to right: two types of pruning saws and a rice knife (also called a Japanese sickle) for cutting masses of stems together; a hand hoe for digging into soil beneath a root if needed, and pruning shears for cutting off individual stems.

with serrated blades can be used to undercut the roots and stems below the girdles as a mass. The key is to reduce the weight of the sawdust by having one person pull up on the root mass with a rake while another person cuts below. Cutting the layers as a mass also reduces tearing on roots, thereby enhancing their survival.



This mass of rooted layers was harvested with a pruning saw and thus has very few torn roots. Individual layers will need to be worked apart in a tub of water.

Post-harvest handling of rooted layers.

The job of working individual layers free from the mass takes patience. It is best accomplished by swishing them around in a big basin of water. The next step is to trim off broken roots and roots that are so long that it will be difficult to make a planting hole large enough to accommodate them without bending them back on themselves. (Scissors work better than pruners for this.) Although we would like to keep as much root mass as possible, a little root pruning stimulates the roots to branch and grow outwards. This is also when we label each plant with its ID.

We also used to trim the stems back to match the size of the root systems, but now recommend against that practice. Although the original stem often dies, the nutrients in it are translocated back to support growth of the living parts of the plant.

If the weather holds, it may still be possible to plant layers in the fall after they are dug, but if not they can be heeled in for the winter for transplanting in the spring. Entire bundles of stems can be heeled in together. Simply dig a hole large enough to accommodate all of the roots, slightly deeper

than you would dig for field planting, and cover them up until spring. Be sure to keep a record as to exactly how large the root system is so you do not damage them when you dig them up. Another storage option is in a cooler or root cellar at about 34 F (1 C). Either pack the roots in moist sawdust, or store them bare-rooted if the humidity can be kept high enough to prevent their desiccation. It is important that the temperature not be much above 34 F because otherwise the stems might break dormancy too soon, which would deplete their energy stores.

This layer would need a hole nearly three feet wide if we didn't trim off its longest roots. It is so vigorous it won't miss them. We wish that all our layers were this vigorous, but have found that layers with much smaller root systems have a good chance of survival if well cared for.



Planting Layers

Those familiar with planting hazelnut seedlings might be surprised to see the morphology of the roots on healthy mound layers. They grow outwards from the stem in a relatively flat plane, which means that mound layers need a different kind of hole than seedlings do. They need wide and shallow transplanting holes, only about six to eight inches deep, to match the shape and size of the plant's root system. It may be difficult to make holes that are so flat and wide unless the ground is in a friable planting condition, so we recommend rototilling first. Ideally, we would shape the soil in the bottoms of the holes into a slight cone, so that the roots drape over it, angling slightly down, similar to how asparagus is planted. But this is more work than practicable, so a flat-bottomed hole is fine. Just spread the roots out on the bottom of the hole like a spider, taking care not to let them crisscross or bend inwards at the edge of the holes. Working quickly so the roots don't dry out, use a rake to cover the roots with about three to four inches of soil. (If they are shallower than that they are vulnerable to winter freeze thaw damage.) Tamp the soil down with your feet, then water. (If the water re-exposes the roots, cover them again.)

If the stems are particularly tall, stake them with bamboo stakes. Place the stakes before planting, so that you don't damage the roots while you poke the stakes in the ground. The stakes should be removed once the plants are established. We also strongly recommend mulch or weed mats, and tree tubes or some other kind of wind protection.

For more advice on transplanting hazelnut layers, see our "Hazelnut Production Guide", available at <https://www.midwesthazelnuts.org/publications.html> under "Hazelnuts 101".

The instructions above are for well-rooted layers. We put weak layers in nursery beds where they receive extra care for a year or two before we plant them out. The weakest layers are grown out in pots for a year or two.

Layering in Successive Years

Although hybrid hazelnuts are tough and can take a lot of abuse, mound layering is especially hard on them. If done too many years in a row it can weaken their root systems to a point where they do not recover. Basically the root systems starve, because they were deprived of photosynthetic nutrition from their leaves all season. That is why it is so important to maintain a nurse stem or two if you plan to mound layer hazelnuts for successive years: the nurse stem feeds the root system.

We do not know how many years in a row our hybrid hazelnuts can be layered. It probably depends on the vigor of the plant in question. Our observations suggest that two years of layering followed by a one year-rest is optimal for most plants, though some plants might be able to be layered only one year, whereas others might go for three. You can tell by how vigorous the new suckers are. If, by the time you are ready to implement layering in later June or July, you find that there not enough suckers that are pencil width or larger, then the plant is probably too weak and you would be better off giving it a year or two off before attempting to layer it again.