Eastern Site Issues for European Hazelnut Orchards

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The European hazelnut is an emerging crop in eastern North America. There are wonderful hazel sites, horrible hazel sites, and everything-in-between hazel sites. Starting a hazel orchard is a big investment with little return for several years. It is a shame to start out on a poor site and several years later have the trees tell us they don't like the place.

Climate:

The northern and southern hazel climate limits are generally understood. If you are on the edge or beyond, you need to be no more serious than a hobbyist. At the southern limit the problem is an inadequate dormancy period. Various varieties need from 600 to 1200 chill hours between 32 and 45 degrees Fahrenheit.

I have given Tonda di Giffoni, a low dormancy requirement variety, to my nephew in Jacksonville, FL multiple times. They look good the first year, but wake up and wither the next spring. He needs to move about half a state north. These plants need their dormancy, so the southern limit would follow the 600 or 1200 map lines, depending on the variety.

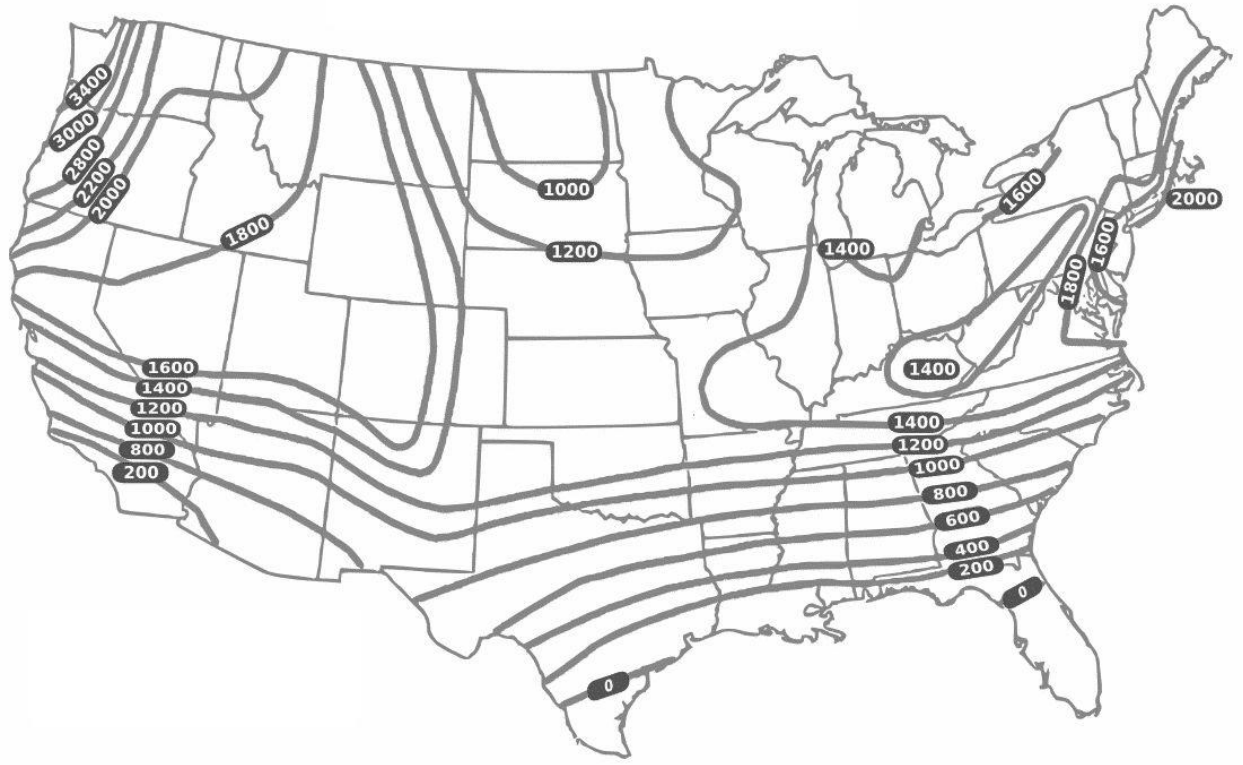

Figure 1. Chill Hours between 32-degree and 45-degree Fahrenheit.

The northern commercial limit is somewhere around mid-MN, WI, MI, NY, and southern ON. I'm not sure of the specific biological problem, but I have seen dieback to ground level. Commercially, the problem is catkin injury during the winter flowering period and the inability to grow vigorous European plants. There is a lot of interest in MN, WI, MI, and ON in pushing the commercial zone further north by crossing the European hazel with the hardier American and bearded hazel species.

Weather:

If you are in the happy, in-between zone, a lake effect would be helpful. Oregon's Willamette Valley (where most commercial hazelnuts are grown) is just downwind of the Pacific Ocean. For lake effects, that is hard to top. Here in West Virginia, have zero lake effect. Our problem is the wide swings of late winter temperatures. A couple of days of seemingly welcome tropic weather bring out the female and male flowers making them vulnerable to freeze damage. Then the temperature plunges to arctic cold and wrecks the exposed flower structures – catkins more so than stigmas. If varieties are divided into three groups: early, mid, and late flowering, it seems that at least one of the three groups at random gets wrecked most winters. The last two flowering seasons, 2020 and 2021, we had "Oregon" winters and all varieties flowered okay.

Soils:

Even between the climatic extremes, trouble may hide beneath the surface. The requirements for filberts are poorly understood for eastern North America's soil types. Hazels are a very rare crop for the East, so hazels are not built into the knowledge base of eastern agricultural services. Advice might be limited to "deep, well-drained" and "neutral to slightly acid pH". The closest crop for comparison is probably a standard sized

Figure 2. Black walnut height tells the story about the underlying soil's suitability

A Black Walnut Diversion:

We have a black walnut plantation on our farm. The USDA/USFS has a concept called "Site Index". The Site Index is based on climate and soil. The final output is how high a timber species will grow at age 50. By examining soil structure, soils experts can tell how high a tree will grow before it is even planted – amazing!

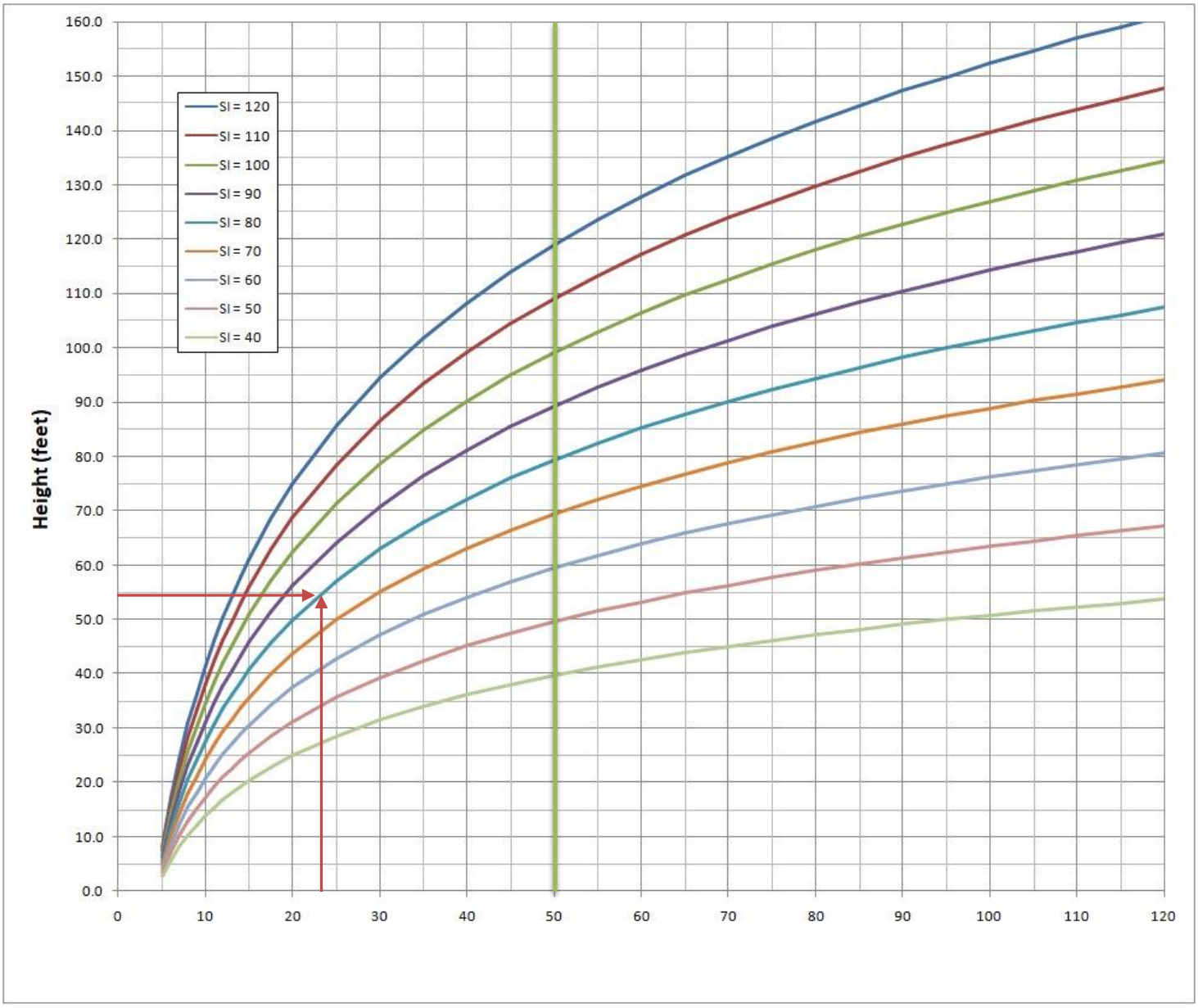

Figure 3. Black Walnut height growth versus age for various Site Indexes

A black walnut's height tends to increase along one of the above curves depending on the quality of the site. For an example, our 23-year-old black walnut monoculture plot is 54 feet tall, so that site index (shown by the red arrows) hits right on the SI = 80 line (they will be 80 feet tall at age 50.) Using the chart above, a grower can determine the Site Index by measuring tree height as early as age 15. That is a little late. A soils expert can estimate the site index before the trees are even planted. Black Walnuts are a large and wise tree. They hold onto the planet by a large root-ball. They refuse to grow taller than the root-ball can support against wind and ice storms. After analyzing thousands of soils and plantings, soil scientist observed that soil "depth to a restrictive layer" accounts for most of the site variation. Restrictive layers can be bed rock, hard pan, dense clay, pure sand, or water table.

Back to Hazels:

Our fruit and nut trees have the same concerns as timber trees, but on smaller scales depending on the species and size.

We have an area in one of our hazel orchards that is now clearly "unsuitable". I planted the whole place without regard to soil maps or soil samples. "We'll let the trees decide." They looked great, but after 7 years, problems emerged. Some trees died back to ground level. Hazels surrounding the death zone are now also showing decline. In this case, the problem is out of sight below ground, a high water-table.

Figure 4. This hazel is telling me "Very Unsuitable"

Most farms have a variety of soils. You might think of keeping field crops in the good areas and planting hazels in the poorer areas. That is a great idea, but unfortunately it probably won't work. The bigger the plant, the more usable soil depth the plant needs. So, in general, tree crops need more usable soil depth for full production than annual row crops with smaller root systems.

What we are finding is the usable soil requirement has two parts. A certain usable soil depth is required to keep the plant alive and growing (with no nut production). An additional amount of soil depth is needed for any crop production. In other words: "Staying alive trumps reproduction."

Figure 5. Three missing trees (red circles) in the foreground of row 2, then distressed trees (arrows) on each side of the death zone

Parts of rows 2 and 3 of our new orchard are a good example of the impact of usable soil depth. The rows were planted in 2014 and the plants grew with reasonably equal vigor for seven years. During a brief drought in July of 2020 problems started to appear. The first sign was a reduction in the density of foliage, then things got worse. I peeled off bark and sent off tissue samples and found nothing significant – the problem must be below the surface.

Figure 6. Average depth to water table and relative size and nut production for trees along row 2. Trees number 20, 21, and 22 died during a 6-week drought in 2020

In 2019 the tree size was measured using the "Big Tree Champion" formula. (Champion points equal stem diameter in inches plus height in feet plus 1/4th of the crown diameter.)

After the dry summer of 2020 nut production for each tree in row 2 ('Jefferson') and row 3 ('Yamhill') were recorder and samples were tested for good kernel yield for the two varieties

Several water table wells were installed along rows 2 and 3 by sinking a ¾-inch diameter perforated pipe vertically to a depth of 48 inches. The depth to water measured periodically from mid-2020 through the 2021 growing season.

The size of each tree relative to the largest tree and nut production relative to the most productive tree in row 2 were compared to the depth of the water table.

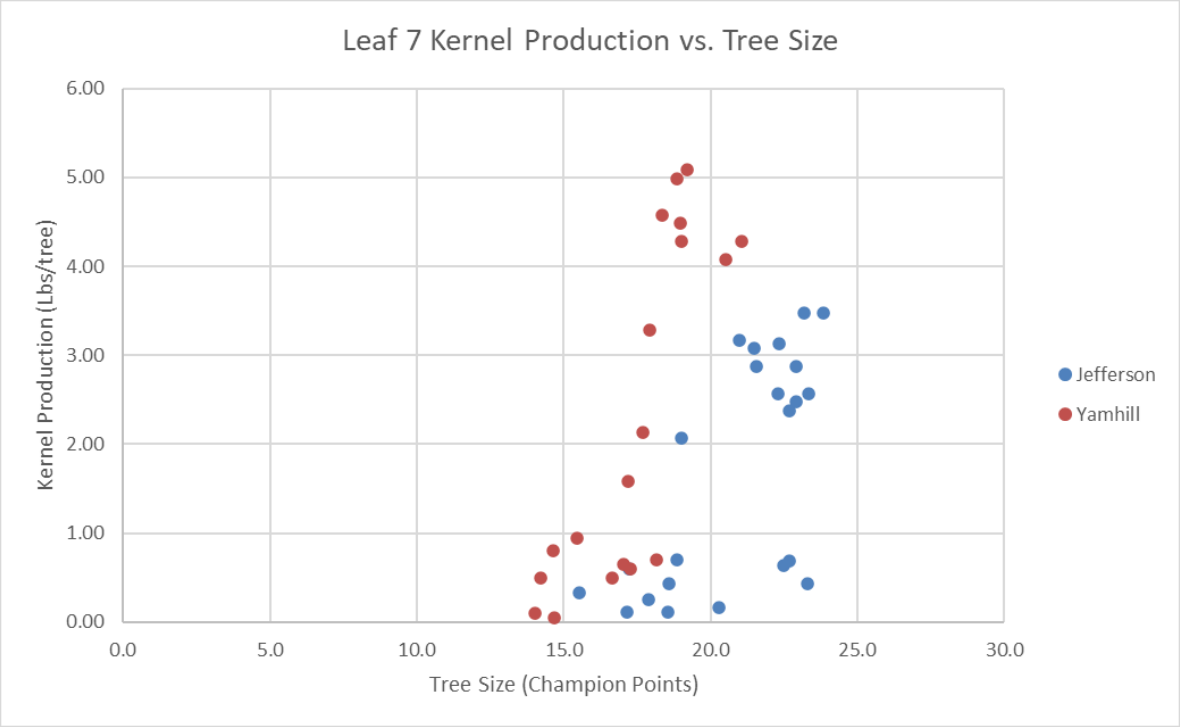

Figure 7. Data from rows 2 and 3 show that when size is suppressed slightly, good kernel production is near zero. Staying alive comes first.

Figure 6. The high water-table forced this tree to grow a "pancake" root system. A 6-week mid-summer drought dried the surface soil downward enough to kill the tree, even though there was plenty of water a few inches below. Roots cannot react fast enough to respond to the short-term changing moisture pattern.

Conclusion:

As regards the climate for European hazelnuts, the area north of the 1200 chill-hours line and south of 43 degrees latitude, I would call the Goldilocks zone. These boundaries would be warped by the great lakes and are generally a bit fuzzy.

Even within the Goldilocks zone, without a major lake effect expect varieties to randomly have flower damage by a warm/cold winter one-two punch. A mix of early, mid, and late flowering varieties will average the economic impact.

The county agent always says “deep well-drained soil”. How deep? What’s apparent here is:

1. With only a foot of usable soil, 7-year-old European hazels may die during a brief drought.
2. With 30 inches of usable soil, 7-year-old plants are nearly full size, but nut production is greatly suppressed.

As the plants get bigger, they likely will need more soil depth, but that is speculation. I’m sure they will eventually tell us the truth.

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