

Hybrid Hazelnut Performance Trials

Effect of Tree Tubes on Hazelnut Establishment and Growth

Jason Fischbach, UW Extension Agriculture Agent, Ashland and Bayfield County
Matt Cogger, UW Extension Hazelnut Research Assistant

Introduction

There is a growing interest in the production of hazelnuts in the Upper Midwest utilizing crosses of the European and American hazelnuts. Many of the early-adopter growers trialing these hybrid hazelnuts are new to agriculture and would like to grow the hazelnuts organically. Available plant material is often sold as containerized seedlings with limited root mass and only 3-4 above ground nodes. The seedlings are typically slow to grow once in the ground. The combination of grower inexperience and delicate seedlings has resulted in significant plant mortality as reported by growers (Fischbach and Brassuer, 2010). The mortality is due to a combination of herbivory, competition with weeds, and too little water.

As with all woody plants, adequate water and weed control are essential to successful establishment of hazelnuts. Control of rhizomatous grass weeds such as quackgrass or brome is especially important as they can outcompete the seedlings for sunlight, water, and nutrients.

Tree tubes are often used with deciduous woody plants to protect them from deer and rodent herbivory and provide a boost in growth rates. They could be a good option for hazelnut growers as the tree tubes would make the plants easier to see when mowing and would make for easy application of glyphosate (Round-Up®) or organic burn-down herbicides such as acetic acid, as the hazelnut plants would be protected by the tubes. However, it is unknown how hazelnut growth is affected by the tree tubes and whether the added cost of the tubes is worth the investment.

The Wisconsin Hybrid Hazelnut Production Trials were established in the summer of 2011 at four locations in Wisconsin (Bayfield, Spooner, Stoughton, Eagle) with full sibling off-spring from a controlled cross between two hybrids selected by Forest Agriculture Enterprises (Viola, WI). The long term purpose of these plantings is to evaluate the performance of the seedlings, conduct agronomic trials, and demonstrate hazelnut production to the public. Each planting has roughly 300 hybrid plants. To evaluate the effect of tree tubes, a tree tube trial was established at the Bayfield and Spooner plantings.



Photo 1. A tree tube can be useful to protect vulnerable seedlings from wind and herbivory while also making it easier to control weeds with glyphosate or mowing. The tubes also result in excellent growth, but the long-term effects on precocity and yield are unknown. Picture at left: hazelnut seedling at planting. Picture at right: hazelnut seedling 13 months later.

Methods

The full-sibling hybrid plants were provided by Forest Agriculture Enterprises. The plants were started from seed in a 1 quart round pot in February 2011 in a greenhouse, transferred to a cold frame, and planted in June at the Bayfield and Spooner locations. The seedlings were roughly 6" tall with 5-6 nodes (Photo 1). At the Bayfield location the plants were planted on June 15, 2011 and immediately mulched with 4" of woodchips. A 30" Tubex Vinegro® tree tube with a 1" diameter bamboo stake was installed on each plant and left there until May of 2013 (Photo 2, top). In addition, at both sites, 1-0 bareroot dormant American hazelnut seedlings (*Corylus americana*) were planted every fourth plant within each row. All the plants were watered using drip irrigation. Weeds were controlled with glyphosate applied once in 2011 and once in 2012.

At the Spooner location, the plants were planted on June 20, 2011 and immediately mulched with green-chop orchardgrass (Photo 4). The same tree tubes were installed and weeds were controlled with hand-pulling and glyphosate applied once in 2011 and 2012. There was no supplemental water.

At both Bayfield and Spooner, the tube trial was implemented starting the spring of 2012 with a randomized complete block design with 16 replications at Bayfield and 26 replications at Spooner (Photo 3). The tube treatments were no tube (full tube removed in spring of 2012), 15" grow tube (full tube shortened to 15"), or the full 30" tree tube (full tube left in place). All tubes were then removed at bud break in 2013. At Bayfield, additional treatments were added outside the main plots with full tubes removed on August 17 or September 24, 2012.

Survival percentage for each of the plantings was calculated in the spring of 2013 after bud break by counting the number of living plants and dividing by the total number planted. In the spring of 2013 after bud break, the total height of each stem was measured along with the height to the apical most living bud on that stem. A stem was considered a stem rather than a branch if the stem originated from within 2" of the ground. The tallest stem is reported as "Maximum Plant Height", the sum of the length of each stem to



Photo 2. Tree tubes can be part of a management system using mulch and herbicides (top, Bayfield planting). The tree tubes can also make it easier to see the plants if the weeds get out of control and mowing is the only option (bottom, Stoughton planting).

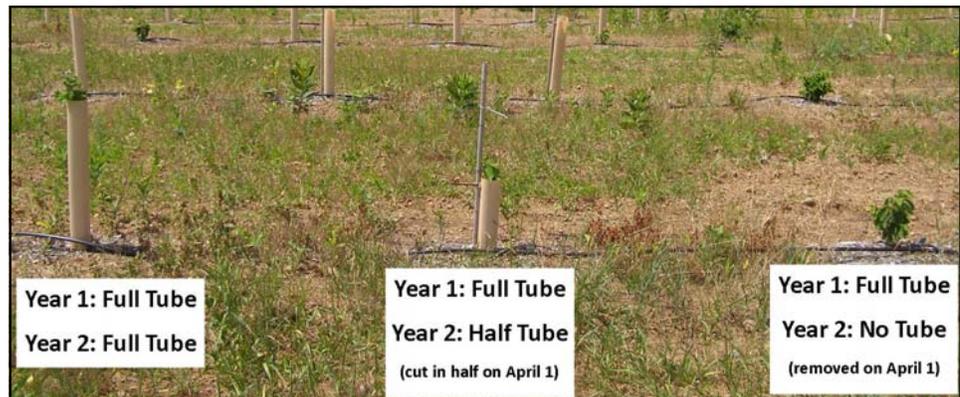


Photo 3. This study evaluated the effect of a full 30" tube on hazelnut seedling growth compared to a half (15") tube and no tube over the first two years after planting. Plant performance data was collected in the spring of 2013.

the apical most living tissue is reported as “Total Green Stem”, the number of stems is reported as “Total # of Stems”. Percent winter kill was calculated by dividing Total Green Stem by the total height of the stems.

Results

Survival

Survival at the Bayfield and Stoughton sites was excellent with 90% or higher survival rates (Table 1). Spooner survival was good, but did experience some mortality after the first year likely due to lack of sufficient water on the dry soils in 2011. Survival at the Eagle site was poor due to extreme drought and heavy Japanese beetle feeding during the summer of 2012. Survival of the plants was not affected by tree tubes (data not shown).

Table 1. Hybrid and American hazelnut survival after two years at four locations.

Location	Hybrids	C. americana
Bayfield	93%	100%
Eagle	61%	NA
Spooner	84%	97%
Stoughton	90%	81%

Growth

Growth of the hybrid seedlings within the tubes was excellent with robust multi-stemmed plants by the end of 2012 (Photo 4). At Bayfield, plants grown in the tubes for two years had fewer but taller stems than plants grown without tubes (Table 2). The full tubes resulted in more total green stem growth than plants in both half tubes and no tubes. There was no difference in total stem growth between half and no tube plants. There was little winter kill in any of the plants at Bayfield after the 2012 winter and no statistically significant difference among plants with full tubes, half tubes, or no tubes. Removing the tubes in the late summer or early fall (presumably to allow for hardening-off) instead of leaving them on over the winter had no statistically significant impact on winter hardiness of the plants.



Photo 4. Plants grown in tubes had 3-4 stems and had fully filled the tubes by the end of the second year.

At Spooner, plants grown in the full tubes tended to be taller than plants grown in half tubes or without tubes (Table 2). The full tubes also resulted in more total stem growth compared to plants in half tubes or full tubes. There was more winter kill at Spooner than at Bayfield and plants with full tubes tended to have more winter kill than plants without tubes. On average, the plants in full tubes lost nearly 34% of their stem growth over the 2012/2013 winter compared to only 19% for plants without tubes.

Discussion

On average, plants grown with tubes more than filled the 30” tube with 1-2 main stems and 1-2 more that were around 15”. Photo 5 (center-right) shows a typical plant grown in the tube for two years with the tube removed at the start of the third growing season. The main stems are free to grow and there

Table 2. Hazelnut growth in response to tree tubes at two locations.

Location	Tree Tube	Maximum Plant Height (in)	Total Green Stem (in)	Total # of Stems	Winter kill
Bayfield	Full Tube	32.6	56.6	2.6	12.1%
	Half Tube	22.2	41.1	2.8	4.9%
	No Tube	12.9	42.3	4.2	0.0%
	Tube Removed - August	39.6	70.5	2.7	2.1%
	Tube Removed - September	37.0	55.5	2.2	1.3%
	LSD (.10)	5.1	15.4	0.8	NS
Spooner	Full Tube	29.5	70.1	3.2	33.8%
	Half Tube	19.9	48.7	3.0	27.9%
	No Tube	18.9	40.5	3.0	19.3%
	LSD (.10)	3.8	13.5	NS	14.0%

are a number of branches about 2” from the ground that show excellent vigor into the third growing season. Plants grown without tubes were shorter, but with more stems and branching (Photo 5). Plants grown in the half-tubes were intermediate in height between the full-tube and no-tube plants.



Photo 5. Typical hazelnut plants in May of 2013 at Bayfield as affected by tree tubes. Left: no-tube plant, Center-Left: half-tube plant, Center-Right: full-tube plant, Left: full-tube plant at Spooner with winter kill.

During the study, the tubes provided a valuable service of protecting the plants from herbivory while making it easier to control weeds. The tubes enhanced the growth of the plants making them easier to see when mowing and, due to the height, more competitive with other plants. The tubes did result in more winter kill of the stem growth at Spooner, but even with the winter kill the plants are taller than the no-tube plants.

The effect of the tubes on plant growth, windfirmness, precocity, and nut yield will be evaluated over the coming years. This information will be key to fully understanding the effect of tree tubes on hazelnut production and whether the more rapid early growth is beneficial or detrimental to plant performance over the long term. Until such data are available, growers should take a realistic look at their ability to control weeds, and if such ability is in doubt, grow tubes are likely worth the extra costs (Table 3) as they enhance growth and make weed control easier.

Establishment Year Costs	Spooner	Bayfield	Eagle	Stoughton
Site preparation	\$ 260	\$ 150	\$ 120	\$ 450
Plants	\$ 1,750	\$ 1,750	\$ 1,750	\$ 1,750
Planting	\$ 570	\$ 595	\$ 1,125	\$ 480
Tree tubes (350 tubes @ \$1.59ea)	\$ 558	\$ 558	\$ 558	\$ 558
Mulch	\$ -	\$ 200	\$ 120	\$ 240
Weeding	\$ 425	\$ 454	\$ 120	\$ 435
Drip irrigation	\$ -	\$ 648	\$ 60	\$ 648
Herbicides	\$ 5	\$ 15	\$ 55	\$ -
Total Cost	\$ 3,568	\$ 4,370	\$ 3,909	\$ 4,561
Cost Per Plant	\$ 8.92	\$ 10.93	\$ 9.77	\$ 11.40

Table 3. Actual establishment year costs for each of the four hybrid performance trial plantings.

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The Upper Midwest Hazelnut Development Initiative is a collaboration of researchers in Wisconsin and Minnesota working with early-adopter hazelnut growers to develop an Upper Midwest hazelnut industry.