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## A Simple Method to Improve Hazelnut Grafting

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Received: 19 April 2016

Accepted: 22 August 2016

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### Abstract

Hazelnuts are usually propagated by suckers or layering. However, other methods of propagation have been tested with variable results. Grafting is a method that has a few advantages such as fast multiplication rate, earlier fruiting and reducing sucker removal cost on specific rootstocks. Unfortunately, grafting is difficult due to slow formation of callus in hazelnuts. Here, we report the hypocotyl cleft graft as a simple method to increase the success rate of hazelnut grafting when the scion is coated with a thin layer of paraffin (wax). Two treatments, hypocotyls cleft grafting without paraffin and with paraffin, have been tested. Hazelnut variety Carmela (*Corylus avellana*) has been grafted on etiolated hypocotyls of native hazelnuts (*C. americana*). Uncoated scions had a 9% success rate, while the success rate increased nine times and was 85% when the scion was coated with a thin layer of paraffin right after grafting. This method is suggested for other nut trees such as Persian walnut, which are hard to graft.

**Keywords:** Cleft grafting, Etiolation, Hypocotyl, Paraffin, Rootstock, Scion.

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### Introduction

Traditionally, hazelnuts have been propagated on their own root (Tous *et al.*, 2009) by suckers and layering, but the propagation rate is very low and the trees have a long juvenility period. Nowadays, other methods of propagation, such as grafting, cutting and micro propagation have been used (Olsen and Smith, 2013). These methods have yielded good experimental results but have never been used commercially (Tous *et al.*, 2009 and Ellena *et al.*, 2014).

Grafting is a method of hazelnut propagation which allows fast multiplication of new varieties, admits the use of rootstock, which does not produce suckers (Wilkinson 2005), gives fruits earlier and possibly improves winter hardiness or disease resistant of cultivars grafted on hardy and resistant rootstocks (Hartmann *et al.*, 1990, Janick and Paull, 2008).

Hazelnut grafting has been studied by several

authors who have obtained variable results depending on the kind of grafting, the age of the plant, the time of year and the place (Rodriguez *et al.*, 1989). Unfortunately, grafting is difficult because callus formation in hazelnut is very slow (Tombesi, 1985). Warm temperatures at the graft union has increased grafting success (Lagerstedt, 1981) and has renewed interest in using vegetative rootstocks for hazelnut (Tous *et al.*, 2009 and Janick and Moore, 1996).

The seedlings can be used as rootstock for grafting hazelnut cultivars (Salimi and Hoseinova, 2012). Seedlings can provide vigorous and disease free plants at a lower cost than clonal rootstocks. There are morphological differences in root systems between vegetative and seedling rootstocks. Vegetative rootstocks produce fewer primary roots, often no taproot and have shallower root system (Hartmann *et al.*, 1990).

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Seedling rootstocks of *C. colurna* produce deep-rooted trees that do not blow over in wind storms that topple the shallow-rooted *C. avellana* (Janick and Moore, 1996). The deep-rooted trees are more resistant to drought and non-irrigated orchards, as was reported in almond trees (Rahemi and Yadollahi, 2006). Native hazelnuts (*C. americana*) accessions show a high level of resistance to Eastern Filbert Blight and are cold hardy (Coyne *et al.*, 1998). These accessions when used as a rootstock can transfer these characteristics to the scion (Hartmann *et al.*, 1996).

Grafting on hypocotyl of seedlings has increased the success rate in walnut (Gandev and Dzhuvinov, 2005; Vahdati and Zareie, 2005) and chestnut (Park, 1968; Ackerman and Jayne, 1980; Vieitez and Vieitez, 1981; Serdar *et al.*, 2005; Duman and Serdar, 2006; Serdar, 2009; Georgi *et al.*, 2013, and Galic *et al.*, 2014). Other advantages of hypocotyl grafting is the ability to graft hazelnuts year round, decrease juvenility of the trees by using mature scion, have access to unlimited supply of scion wood and the fast rate of tree multiplication.

Our goal was to test the possibility of using cleft grafting on the hypocotyl and to improve the success rate of hypocotyl graft in hazelnut by waxing the scion.

## Materials and Methods

### Plant Material

Seeds of American hazelnut (*C. americana*) were collected from Southern Ontario by St. Williams Nursery (Norfolk, Ontario, Canada), and seedlings planted at Simcoe Research Station (University of Guelph, Ontario, Canada) in 2011. At the end of September 2015, open pollinated seeds were collected from a single native hazelnut tree and were dried out at room temperature. On 23 November 2015, husks were

removed and seeds were soaked for 48 hours in tap water at room temperature. The seeds were then disinfected in bleach (1:1 bleach: tap water) for 2-3 minutes, drained and placed in moist vermiculite (Therm-O-Rock expanded vermiculite, #2A, CAS #1318-00-9) in zip lock bags. Seeds were stratified at 1-3 °C at darkness from 27 November 2015 to 8 April 2016. The seeds were then moved to a growth chamber to germinate at 22 °C and darkness till 29 April 2016. Germinated and etiolated seedlings were then used as a rootstock for the hypocotyl grafting.

For scion, hazelnut dormant woods of 1 meter were pruned from variety Carmela at Grimo Nut Nursery, Niagara on the Lake, and Ontario, Canada in 13 March 2016, bagged in large transplant plastic bags, shipped to Simcoe overnight and placed in cooler at 1-3 °C and darkness.

### Cleft Grafting

In 29 April 2016, germinated seeds were cleaned from vermiculite and used as rootstocks for hypocotyl grafting at their thickest part (about 1-3 cm from the base, 2-3 mm thickness) with small dormant branches ( $9.3 \pm 2.1$  cm and  $2.6 \pm 0.3$  mm thickness) of Carmela variety as the scion. Attempts were made to use scion with the same diameter as the rootstock and to keep both cambiums in close contact. Before grafting, the working bench was sterilized with 70% alcohol and the scion and rootstock with 3 % hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) spray.

A horizontal cut was made at the etiolated hypocotyls at about 5 cm from the base at their thickest section. The scion was then trimmed to form a wedge and a vertical cut made into the hypocotyls to form donor wedge in which to insert the scion (Fig. 1). The graft union was then wrapped with a couple of layers of Parafilm "M" (Pechiney) strips (3-4 mm wide).

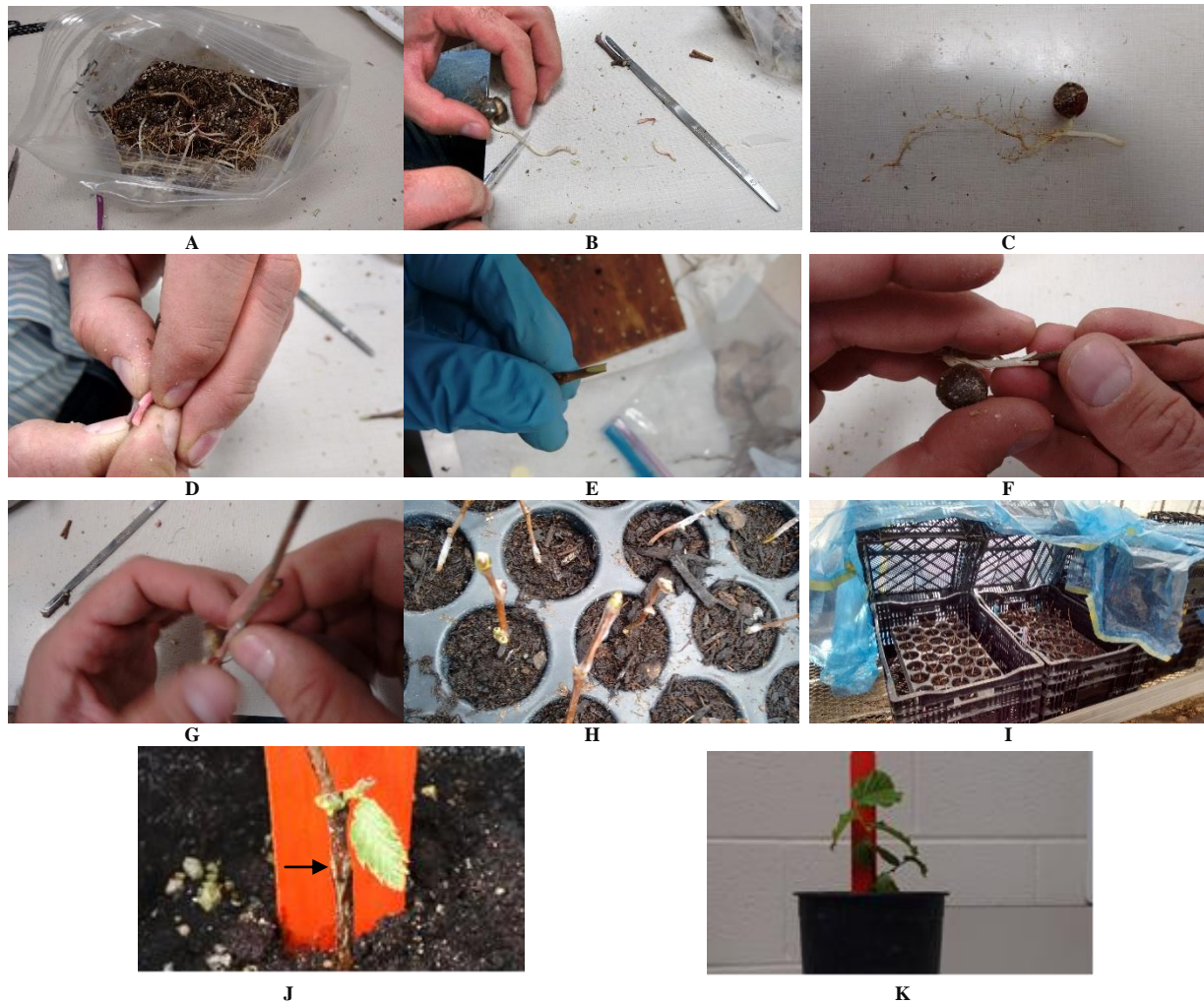


Fig. 1. Pictures of grafting of hazelnut variety Carmela onto the etiolated hypocotyl of native hazelnut (*C. americana*) seedlings. A) Zip lock bags of germinated seedlings of native hazelnuts grown in vermiculite in darkness, B) The etiolated and elongated hypocotyl was cut horizontally about 5 cm from the base at its thickest section, C) an etiolated seedling with horizontal cut, D) a vertical incision was made in the hypocotyl to form a donor wedge, E) the base of the scion (with the same diameter of rootstock, about 2-3 mm and average 4 buds) were trimmed with a sharp surgical blade into a gently sloping wedge, F) the wedged cut scion was inserted into the donor wedge of the rootstock, G) the graft union was wrapped with a strip of Parafilm 3-4 mm wide, H) the grafts were planted in plug trays in Fafard Agromix N7 soil, I) the plug trays were placed in a bulb box and was covered by another box and a blue layer of plastic to maintain the humidity under plastic, J) The arrow is pointing to grafting union, K) grafted hazelnut after transplanting to a 2.84 L pot.

There were two treatments, with one being the control group. In the control, grafts were planted right after grafting and in the second treatment, the scions were dipped for one second in warm (55°C) white soothing Paraffin (Conair, *Aloe vera* wax included) and dipped immediately in cold water to prevent heat damage. A total of 42 grafts were made without paraffin and 34 with paraffin coating on the scion. The grafted seedlings were then planted in five replicates in 38 cells plug trays (Sure Roots 38 Deep Cell Plug Trays, 12.5 cm deep) in Agromix N7 soil (Fafard et Frères Ltd., Canada) and placed in greenhouse with automatic

curtain and kept in boxes (BE-lily bulb box type 4150/A) with blue plastic sheets to maintain humidity. Grafted plants are watered daily and the soil was kept at field capacity the entire time. The data were analyzed using general linear model (GLM) (SAS Institute Inc., version 9.2).

Buds started to swell a week later. On 15 May 2016, the rates of successful grafts were scored. Buds on unsuccessful graft did not swell and died (scored 0), while buds on successful graft sprouted (scored 1). The grafted tree was gradually adapted to increased light intensity and decreased humidity of the greenhouse.

They were kept in the controlled environment during summer and to be planted outside in early fall.

**Results**

As far as we know, this is the first report on grafting hazelnuts at hypocotyl stage and to coat the scion with

paraffin. Our success rate when scion was coated with paraffin is 85% and when it is not, was 9.5%. The rate of graft success was nine times higher in paraffin coated grafts compared to the control group (Table 1).

**Table 1. The percentage of successful hypocotyl grafts in hazelnuts, when scion was not coated or was coated with paraffin. Rootstock is etiolated seedlings from native hazelnut (*C. americana*) and scion is the variety Carmela.**

	No. of grafts made	No. of successful grafts	Percentage of successful grafts
Scion was not coated	42	4	9.5
Scion was coated with paraffin	34	29	85.3
LSD			0.13

Note: LSD (least significant difference created confidence intervals for pair-wise differences between the two level means while controlling the individual error rate to a significance at p=0.001)

**Discussion**

Anecdotal evidence in other fruit trees suggests that grafting success increased when the scion was covered with paraffin. The paraffin or grafting wax reduced water transpiration from scion at the early stages of grafting, when there was no established connection between the scion and rootstock. This helped the scion maintain their water content and increased grafting success.

There is not any report on the hypocotyl graft in hazelnut. The success rate in walnut hypocotyls graft is 70% (Vahdati and Zareie, 2005) and in chestnut is 28% (Georgi *et al.*, 2013). The success rate reviewed by Serdar (2009) varied from 0 to 100% in hypocotyl graft in chestnut. Our success rate when scion was coated with paraffin falls in a high range compared to other reports. The high success rate could be due to the effect of paraffin on scion and its ability to restore the water content of the scion. The other factor that may have increased our success rate is the etiolated rootstock. It has been shown that etiolation changes the phenolic substances and/or anatomy of the tissue to increase undifferentiated callus formation (Hartmann *et al.*, 1990). The results suggest that etiolated hypocotyls graft has the potential to increase the graft success especially

when the scion is protected from water loss by waxing. We also suggest this method for other nut trees such as walnut which are hard to graft.

**Acknowledgements**

We are grateful to Dragan Galic for his assistance in this research. The authors also thank Grimo Nut Nursery and St. Williams Nursery for providing the germplasm and to Fafard et Frères Ltd., for providing the substrate mix.

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