Evaluation of *corylus avellana L Cvs* propagated by rooted suckers and grafting

Evaluación de *Corylus avellana L Cvs* propagado por brotes enraizados e ingerto *

Avaliação do *Corylus avellana L Cvs* propagado por enriquecidos e ingerto*

Diana Carolina Carvajal Rodríguez **
Sergio Tombesi ***
Miguel Ángel García Parra ****

Fundación Universitaria Juan Castellanos – Colombia
Università Cattolica del Sacro Cuore Sede di Piacenza e Cremona: Piacenza, Emilia-Romagna, Italy
Universidad del Cauca - Colombia

Fecha de Recibido: **Febrero 25 del 2018**
Fecha de Aceptación: **Mayo 01 de 2018**
Fecha de Publicación: **Julio 01 de 2018**
DOI: http://dx.doi.org/10.22335/rlct.v10i3.631

* Article derived from the investigation "Evaluation of corylus avellana L Cvs propagated by rooted suckers and grafting".

** Agricultural Engineer, Fundación Universitaria Juan de Castellanos (Colombia). Member of Research Group AOF. Email: krito22@hotmail.es Orcid: https://orcid.org/0000-0001-8890-3746
*** PhD. Agricultural Sciences, Università Cattolica del Sacro Cuore, Dipartamento di Scienze delle Produzioni Vegetali Sostenibili. Email: Sergio.tombesi@unicatt.it. Orcid: https://orcid.org/0000-0002-5126-0561
**** Agricultural Engineer. Doctorate student in Agrarian and Agroindustrial Sciences. Cauca University (Colombia). Member of Research Group AOF. Email: miguelgarciap@unicauca.edu.co Orcid: https://orcid.org/0000-0001-8541-5181

Abstract

Hazel belongs to the genus Corylus, where we find as economic interest to European Hazel (C. avellana L). Recommended cultivars for Italy are Tonda di Giffoni, Tonda Gentile delle Langhe (TGL) and Tonda Romana (TR), because of their nut quality, productivity, vigor and type of growth. Hazelnut is commonly propagated vegetatively by rooted suckers, layering and grafting. Grafting is particularly interesting because the use on non-suckering rootstock can consistently decrease crop

cost. The aim of this work was to evaluate the behavior of the cv Tonda di Giffoni propagated by rooted suckers (TG) and grafting. Furthermore, it was compared the reproductive activity of cv TGL and TR propagated by grafting. Tonda di Giffoni grafted (TGi) borne shorter (174.2 cm) and fewer shoots (12.2) compared with plants propagated by rooted suckers (362,8 cm, 18.6 and 120,53); grafted plants had higher density female flowers than own rooted plants; the same was for fruit set that was larger in grafted plants than in own-rooted plants (66.6%).

Key words: Propagation, Development, Vegetative vigour, Cultivars.

Resumen

El avellano pertenece al género Corylus, donde encontramos un interés económico en Hazel Europeo (C. avellana L). Las cultivares recomendados para Italia son Tonda di Giffoni, Tonda Gentile delle Langhe (TGL) y Tonda Romana (TR), debido a su calidad, productividad, vigor y tipo de crecimiento. La avellana comúnmente se propaga vegetativamente por brotes enraizados, capas en injertos. El injerto es particularmente interesante porque el uso en portainjertos no enraizados puede disminuir consistentemente el costo de los cultivos. El objetivo de éste trabajo fue evaluar el comportamiento del cv Tonda di Giffoni propagada por brotes enraizados (TG) e injertos. Además, se comparó la actividad de cv TGL y TR propagada por injerto. Tonda di Giffoni injertado (TGi) nace más corto (174,2 cm) y menos brotes (12,2) en comparación a las plantas propagadas por brotes enraizados (362,8 cm, 18,6 y 120, 53); las plantas injertadas, tuvieron la más alta densidad de flores femeninas que las plantas enraizadas; lo mismo ocurrió con los frutos, fueron más grandes en plantas injertadas que en plantas enraizadas (66,6%).

Key Words: Propagación, Desarrollo, Vigor vegetativo, Cultivares.

Resumo

A avelã pertence ao gênero Corylus, onde encontramos um interesse econômico na Hazel Europeo (C. hazelnut L.). As cultivares Itália Tonda di Giffoni recomendados são, Tonda Gentile delle Langhe (TGL) e Tonda Romana (TR), por causa de sua taxa de qualidade, produtividade, vigor e crescimento. Avelã é comumente propagada vegetativamente por brotos enraizados, camadas em enxertos. O enxerto é particularmente interessante porque o uso em porta-enxertos não enraizados pode reduzir consistentemente o custo das culturas. O objetivo deste trabalho foi avaliar o comportamento de Tonda di Giffoni cv propagada por brotações enraizadas (TG) e enxertos. Além disso, a atividade de cv TGL e TR propagada por enxertia foi comparada. Tonda di Giffoni enxertado (TGi) carregado mais curto (174,2 centímetros) e menos botões (12,2) em comparação com as plantas propagadas por rebentos com raízes (362,8 cm, 18,6 e 120, 53); as plantas enxertadas tiveram a maior densidade de flores femininas que as plantas enraizadas; o mesmo aconteceu com os frutos, eles foram maiores em plantas enxertadas do que em plantas enraizadas (66,6%).

Palavras-chave: Propagação, Desenvolvimento, Vigor Vegetativo, Cultivares.

Introducción

Corylus genus has 25 species, C. avellana L. or European hazelnut is the most interesting one for cultivation (Lavín & Reyes, 2014). C. avellana is shrub, with branches of brown clear grayish color. A large number of suckers are borne from the neck of the plant. Suckering capability depend on the cultivar: it is high for Tonga di Giffoni, Tonda Gentile delle Langhe, and Tonda Romana, or limited in Dundee, Newberg (C. avellana x Corylus colurna), C. colurna (Ellena & Sandoval, 2013). C. Avellana is a monoecious dicline speacies meaning that female and male flowers are borne separatelly but on the same individual. Male flowers are grouped in inflorescence called catkins and the female flower is called glomerulus (Lavín & Reyes, 2014); The fruit

can be unique or gathered in infructescences composed by 2, 3 or more fruits (Ellena, 2010).
Tonda di Giffoni is a cultivar apreciated because of the productivity, the kernel blanching, rapid growning, medium vigour, a remarkable protandry and self-sterility; early female and male flowering (Tombesi & Limongelli, 2002, Grau, 2003 & Ellena, et al. 2013); Tonda Gentile delle Langhe, was originated in Piedmont, northern Italy; it has remarkable protandry and self-sterility, with habit of intermediate developent and moderate vigour (Ellena, et al. 2013); Tonda Romana, has a medium low vigour, late budbreak, medium productivity , and medium-late maturing (Tombesi & Limongelli, 2002; Grau, 2009).
Hazelnut is commonly vegetative propagated by rooted suckers, layering and grafting (Ercisli & Read, 2001), Rooted suckers are emission of vigorous sprouts from adventitious buds located on the neck of the plant or root. Rooted sucker popagation is simple and inexpensive, but allow to obtain a limited number of plant per each mother plant (Corte, M. & Sonnati, C. 2009, Lobos, 1986); grafting in hazelnut is recomended for the reduction of suckering activity (Thompson, 1984 citado por Medel, 1989), but it is not currently a common technique, because of the limited availability of rootstocks and the limited percentage of grafting sucess (Lobos, 1986). The aim of the present work was to evaluate the effect of grafting and sucker propagation on vegetative and reproductive parameters during the first year after planting..

Material and methods

The present study was carried out in the experimental greenhouse of the Università Cattlica del Sacro Cuore in Piacenza, Italy, at an altitude of 66m at coordinates 45º 03' North latitude - 09º 41' East longitude. Three cultivars of European hazelnut (Corylus avellana L.) were used: Tonda di Giffoni (TG), Tonda Gentile delle Langhe, (TGL) and Tonda Romana (TR). A total number of 40 plants was used: 30 plant of TG, of the which 15 were propagated by rooted suckers and the other 15 by grafting, the remaining ten were TGL and TR, five plant per each propagated by grafting. All grafted plants were grafted on C. Colurna seedlings.
The trial was conducted in February 2017, when he was finishing the season of winter, Plants were 2 years old, in February 2017 1 year old shoot length and number, number of nodes, number of female (N ° FF) and male flowers (N ° FM) was measured. In June the number of fruit per plant and the trunk diameter at the base (5 cm from the ground) was measured. Data were analyzed by Excel and t-test was used to compare treatments per $P<0.05$.

Results and discussion

Shoot length

Plant propagated by rooted suckers borne longer 1-year-old shoots (362,8 cm) in comparrison with plant propagated by grafting (174.2 cm) Evidenced significative differences intro the two methods propagation (Figure 1). The methods of propagation are determinants and in the productivity the trees of C avellana (Solar et al, 1994), while the obtained results had partial discordance with data reported by Ellena et al., (2014), in which Tonda di Giffoni grafted plants were more vigorous than own rooted plants. However, this variable is determined for factors as the presence and availability of nutrients as Nitrogen (N) in the soil (Silvestri, 2015).

In the comparison of the varieties, the TGL had longer 1YO shoots than TG and TR, respectivelluy, due to longer internodes (Table 1). TG born a consistent larger number of female and male flowers than TGL and TR, looking that exist significative differences in each one of the variables, except the number of nodes.

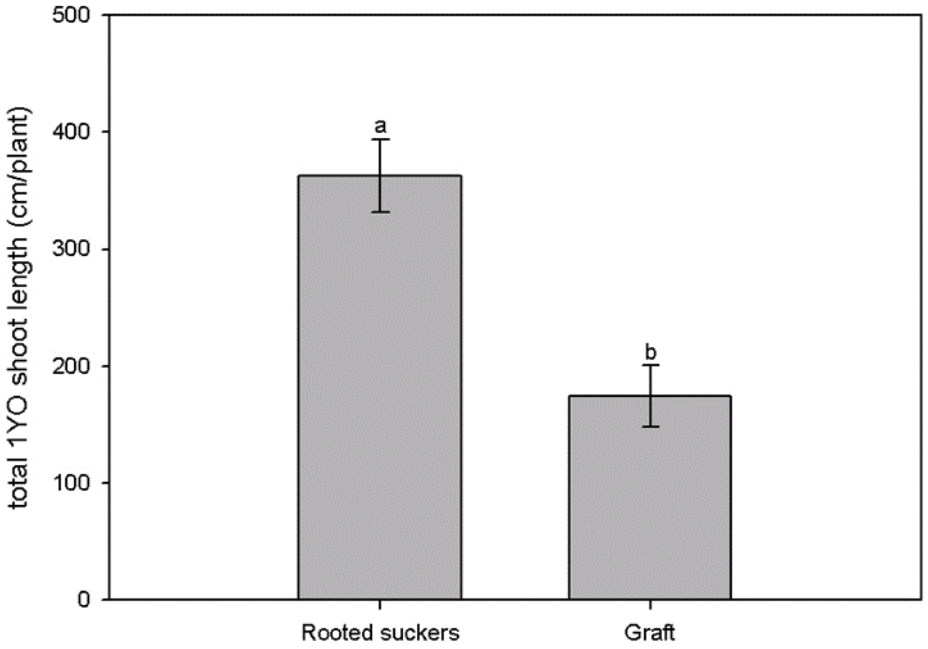

Figura 1. Shoot length in cm of plants of Tonda di giffoni, propagated by root suckers and graft. The different letters indicate signficative difference (1YO= one year old) Fuente: Autores

Table 1.

Comparation of the Tonda di giffoni, Tonda gentile delle langhe and Tonda Romana propagated by graft. Same letters do not present significant difference

Cultivare	Mean Shoot length (cm)	Mean Length of the internode (cm)	Number of Nodes	N° Female Flowers	N° Male Flowers
TGL	208.9 ±37.7a	3.58±0.1 a	57.5±8.6ª	2,25±1.4b	0,25±0.2b
TG	174.2±26.3ab	2.58±0.2b	62.1±6.8ª	5,4±1.3 a	3,93±2.2a
TR	128.0±19.2b	2.32±0.2b	54.8±4.1ª	2,8±1.2b	0,2±0.2b

Fuente: Autores

Number of shoot

Own rooted TG borne more shoots per plant than grafeted TG 18.6 and 12.2, respectivelly similarly to what reported by Rovira, et al. (2013), in the Negret variety plants, grafted on different rootstocks and own-rooted.

There was no significant difference between grafted TG, TR and TGL regarding the number of vegetative shoots borne per plant, suggesting that the effect of grafting decrease the effect of the cultivar on vegetative growth caracteristics that was previously reported to be mainly related to the genotype (Tombesi & Farinelli 2014).

Famele flowers

Female flower density varied depending the shoot lenght: shorter shoots had a larger relative number of buds induced to female flowers (Fig 2). This is

consistent with the results obtained by Santos, et al. (2001) and by Tombesi & Farinelli, (2014) that reported a negative correlation between flower density and shoot length. In own rooted plant the relationship between female flower density and shoot length was similar even though, due to the smal number of female flower borne in these plants, the relashionship resulted down-shifted.

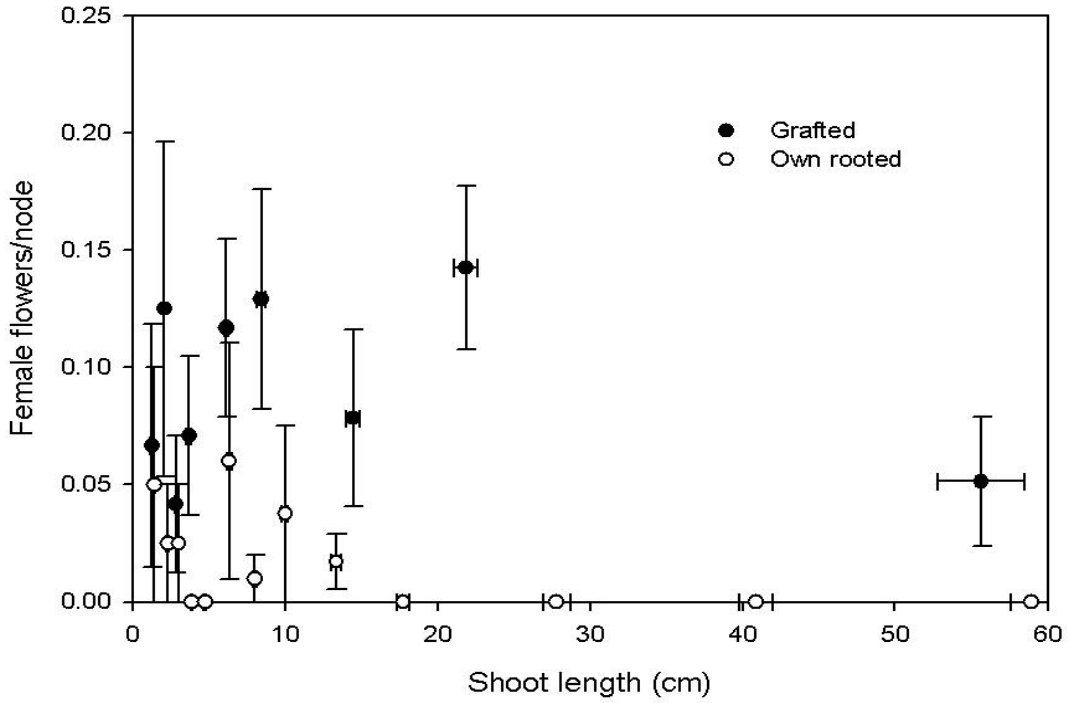

Figure 2. Number of female flowers on the number of nodes in relation to the length outbreak of Tonda di giffoni propagated by root suckers and graft.

Flowering efficiency and fruit set

Grafted TG plant had a larger flowering efficincy than own rooted TG plant regarding female and male flower as well (fig 3 and 4). TR and TGL grafted plant had an intermediate behaviour between own rooted TG and grafted TG pkants.

This indicate that grafting on C. Colurna seedlings can induce an early bearing of flowers and increase the yield efficiency of plants. Infact, the number of nuts yielded by grafted plants was higher than that of nuts borne by own-rooted plants. This was due to larger number of flowers borne by grafted plants and larger fruit set rate that was 66% and 45.8% in grafted and own rooted plants, respectivelly.

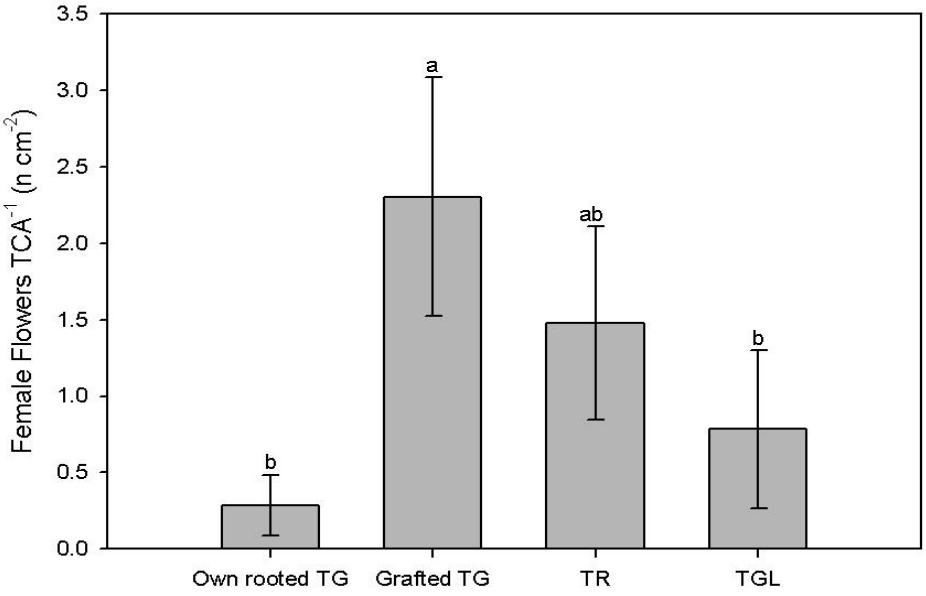

Figure 3. Number of the famele flowers of the cultivars Tonda di giffoni, Tonda gentile delle langhe and Tonda Romana per cm^2 of trunk. The letters diferents indicate significative differences.

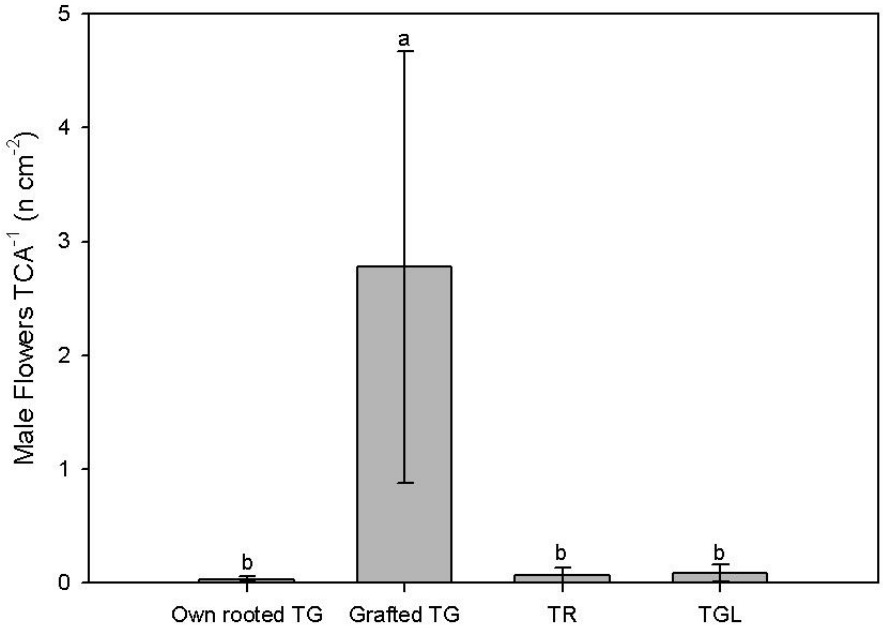

Figure 4. Number of the male flowers of the cultivars Tonda di giffoni, Tonda gentile delle langhe and Tonda Romana by cm2 of trunk.

Conclusions

European Hazel plants propagation can affect vegetative and reproductive behaviour: plants propagated by grafting have lower shoot length, number of shoots and number of nodes in comparrison with rooted-sucker-propagated plant. Grafted plants borne a larger density of female and male flowers suggesting a minor competition between reproductive and vegetative activity.

For the three cultivare of European Hazel (Tonda di giffoni TG, Tonda gentile delle langhe TGL y Tonda Romana TR) prapagated by grafting on C. Colurna seedlings, Tg was the most efficient in bearing female and male flowers, while vegetative growth was mostly pronounced in TGL, TG and TR, respectivelly. In coclusion, on the base of these preliminar data, the use of grafting for hazelnut propagation could allow to decrease the unproductive period and to decrease plant vigour shifting carboidrate partitioning from vegetative to reproductive activity.

References

Asante, A. & Barnett, J. (1997). Graft union formation in mango (Mangifera indica L.). J. *Hort. Science*. 72:781-790. Recuperado de: http://www.tandfonline.com/doi/abs/10.1080/14620316.1997.11515571

Barnett J, & Weatherhead I. (1988). Graft formation in Sitka Spruce: A scanning electron microscope study. Ann. Bot. 61. 581-587. Recuperado de: https://doi.org/10.1093/oxfordjournals.aob.a087592

Corte, M. & Sonnati, C. (2009). La coltivazione del nocciolo in Alta Langa Linee guida per una corilicoltura sostenibile, A cura di: Comunità Montana Alta Langa. 66.

De Stefano E., Costigliola L., Bellizial. & Pasquarella C. (2005). La coltivazione del NOCCIUOLO nella provincia di Avellino (Corylus avellana L.). Università degli studi di Napoli Federico ll Facolta di Agraria

Ellena, M., Sandoval, P. & Gonzalez, A. (2014). Effect of Type of Propagation on Earliness of Flowering and Fruiting in 'Tonda di Giffoni' and 'Daviana' Cultivars. Proc. VIIIth International Congress on Hazelnut. Acta Hort. 1052. 220-224

Ellena, M. (2010). Polinización y Manejo del Avellano Europeo. In tituto de investigaciones Agropecuarias (INIA) Centro regional Carillanca. Boletín INIA N° 2002. ISSN: 0717-4829

Ellena, M. & Sandoval, P.2013. Organografía. In: Ellena, M. Avellano Europeo: establecimiento y formación de la estructura productiva. Boletin INIA Nº274 Instituto de investigaciones agropecuarias - Centro Regional INIA Carillanca, 202p

Ellena, M., Sandoval, P., González, A. & Azóca, G. (2013). Variedades. In: Ellena, M. Avellano Europeo: establecimiento y formación de la estructura productiva. Boletin INIA Nº274 Instituto de investigaciones agropecuárias. España: Centro Regional INIA Carillanca, 202

Ercisli, S. & P.E. Read 2001: Propagation of hazelnut by softwood and semi-hardwood cuttings under Nebraska condition. *Acta Hort*. 556, 275

Grau, P. (2003) Avellano Europeo, Manual de Plantación y Manejo. Chillán, Chile. Instituto de Investigaciones Agropecua- rias. Centro de Investigación Regional Quilamapu. Boletín 108. 74

Grau, P. (2009). Manual de avellano europeo. Boletín INIA Nº 195. Instituto de Investigaciones Agropecuarios, Chil lón, Chile. 96

Lavín A. & Reyes M. (2014). Avellano europeo (Corylus avellana L.) In: Reyes M. & Lavín A. Frutales de Nuez, cinco alternativas no tradicionales para el secano interior del Maule.

Boletín INIA Nº 301. Instituto de Investigaciones Agropecuarias, Cauquenes, Chile. 138 p

Lobos. W. (1986). Antecedentes de propagación del avellano europeo (Corylus avellana L.). Investigación y Progreso Agropecuario Carillanca 5(3) .28-31.

Medel, F., Valenzuela, P., Fuentealba, J., Seemann, P. & Fuentes, (1989). Propagación del avellano europeo (Corylus avellana L.) por estacas de madera Blanca. Universidad Austral de Chile, Instituto de Producción y Sanidad Vegetal, Castilla 567, Valdivia-Chile. Recuperado de: https://www.researchgate.net/publication/275522230_Propagacion_del_avellano_europeo_Corylus_avellana_L_por_estacas_de_madera_blanda. Accesado en: 13/04/2017

Rovira, M., Hermoso, F. Tous, J. & Romero, A. (2013). Comportamiento de la variedad de avellano 'negret' injertada sobre patrones no rebrotantes. Recuperado de: https://www.researchgate.net/publication/267514933_Comportamiento_de_la_variedad_de_vellano_%27Negret%27_injertada_sobre_patrones_no_rebrotantes Accesado 07/062017

Santos, A., Silva, A. & João Franco, M. (2001). Stem Position And Stem Length Effects On Fruit Set Of 'Ennis' And 'Butler' Hazelnut. Proc. V Int. Congress on Hazelnut Acta Hort. 556, 313-320pp

Silvestri, C. (2015). Hazelnut (Corylus avellana L) genetic resources and nursery industry improvement by biotechnological approaches. tesi di dotoratto in Biotecnologie vegetali. Università Degli Studi della Tuscia Di Viterbo. 87.

Solar, A. Smole, F. & Stampare, F. (1994). Investigations of differents methods of propagation of hazelnut (Corylus avellana L.) *Acta Horticulturae*. 351, 381 – 386.

Tombesi A. & Limongelli, F. (2002). *Varietà E Miglioramento Genetico Del Nocciolo.* In: 2° Convegno Nazionale sul Nocciolo, Giffoni V. P., ottobre. Editoriale: Santangelo Italo Regione Campania, SeSIRCA – Napoli. 296, 11-27

Tombesi, S. & Farinelli, D. (2014). Relationships between Flower Density and Shoot Length in Hazelnut (Corylus avellana L.) Proc. VIIIth International Congress on Hazelnut .*Acta Hort*. 1052137-142

Valentini, A., Caviglione, M., Gaiotti, G., D'oria, M. & Giovanni, M. 2007. Metodi adottati per la propagazione di selezioni di nocciolo (Corylus spp.). Tecniche Colturali

Weatherhead, I. & Barnett, J. (1986). Development and structure of unusual xylem elements during graft union formation in Picea sitchinensis L. Ann. Bot. 57:593-598. Recuperado de: https://doi.org/10.1093/oxfordjournals.aob.a087139 Accesado: 23/05/2017

Wyzgolik, G. & Z. Piskornik, Z. (2001). Association Of Phenolic Compounds With Callus Formation And Grafting Success In Hazelnut. Proc. V Int. Congress on Hazelnut Ed. S.A. Mehlenbacher Acta Hort. 556, 269-273pp