

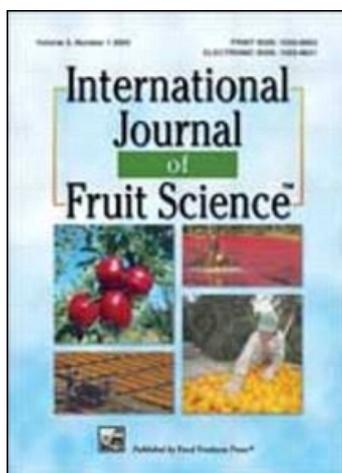
This article was downloaded by: [Monash University]

On: 1 September 2009

Access details: Access Details: [subscription number 907465080]

Publisher Taylor & Francis

Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



International Journal of Fruit Science

Publication details, including instructions for authors and subscription information:

<http://www.informaworld.com/smpp/title~content=t792306963>

Improved Success of Persian Walnut Grafting Under Environmentally Controlled Conditions

Aziz Ebrahimi ^a; Kourosh Vahdati ^a; Esmail Fallahi ^b

^a Department of Horticultural Crop Production, Abourayhan University College, Faculty of Plant and Animal Sciences, University of Tehran, Iran ^b Parma Research and Extension Center, University of Idaho, 29603 University of Idaho Lane, Parma, Idaho, USA

Online Publication Date: 24 September 2007

To cite this Article Ebrahimi, Aziz, Vahdati, Kourosh and Fallahi, Esmail(2007)'Improved Success of Persian Walnut Grafting Under Environmentally Controlled Conditions',International Journal of Fruit Science,6:4,3 — 12

To link to this Article: DOI: 10.1300/J492v06n04_02

URL: http://dx.doi.org/10.1300/J492v06n04_02

PLEASE SCROLL DOWN FOR ARTICLE

Full terms and conditions of use: <http://www.informaworld.com/terms-and-conditions-of-access.pdf>

This article may be used for research, teaching and private study purposes. Any substantial or systematic reproduction, re-distribution, re-selling, loan or sub-licensing, systematic supply or distribution in any form to anyone is expressly forbidden.

The publisher does not give any warranty express or implied or make any representation that the contents will be complete or accurate or up to date. The accuracy of any instructions, formulae and drug doses should be independently verified with primary sources. The publisher shall not be liable for any loss, actions, claims, proceedings, demand or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of this material.

Improved Success of Persian Walnut Grafting Under Environmentally Controlled Conditions

Aziz Ebrahimi
Kourosh Vahdati
Esmaeil Fallahi

ABSTRACT. Different budding methods (patch, shield and chip) were compared under controlled and field conditions using different native varieties of Persian walnut (*Juglans regia* L.) during June 2005, in Nieriz, Fars province, Iran. Controlling temperature and humidity in a greenhouse improved grafting success considerably in all grafting methods compared with results under field conditions. The highest success rate was obtained with patch (91.0%) followed by shield (31.1%) and chip (19.1%) budding under greenhouse conditions versus 25.0, 15.0 and 10.0% under field conditions, respectively. Similar trends were also observed for callus formation and scion growth. Patch budding showed the highest callus formation and scion growth followed by shield and chip

Aziz Ebrahimi is a MSc student, and Kourosh Vahdati is Assistant Professor, Department of Horticultural Crop Production, Abourayhan University College, Faculty of Plant and Animal Sciences, University of Tehran, Iran.

Esmaeil Fallahi is Professor and Research Director of Pomology, Parma Research and Extension Center, University of Idaho, 29603 University of Idaho Lane, Parma, Idaho 83660.

Address correspondence to: Kourosh Vahdati at the above address (E-mail: kvahdati@ut.ac.ir).

The authors thank Dr. Reza Amiri at the Department of Agronomy and Crops Breeding, Abourayhan University College, University of Tehran for advising and reviewing the analysis.

The authors acknowledge financial support received from the Office of Research Affairs, University of Tehran and Iranian National Science Foundation (INSF); and Zareie Fruit and Nut Nursery for supporting the facilities and technical assistance.

budding under both conditions. The genotype used did not affect grafting take using shield and patch budding excluding the N3 selection which had the highest graft success using the shield budding under greenhouse conditions. The best results were obtained by patch budding, under greenhouse conditions in all of the tested genotypes. doi:10.1300/J492v06n04_02 [Article copies available for a fee from The Haworth Document Delivery Service: 1-800-HAWORTH. E-mail address: <docdelivery@haworthpress.com> Website: <<http://www.HaworthPress.com>> © 2006 by The Haworth Press, Inc. All rights reserved.]

KEYWORDS. Walnut, grafting, variety, patch, shield, chip budding, greenhouse

INTRODUCTION

Persian walnut is one of the main nut crops in Central Asia, and is especially important in Iran (Vahdati, 2000). Iran was ranked as the third largest walnut producer in 2005 by producing 150,000 tons which is about 11% of the world walnut production (F.A.O., 2005; Vahdati, 2000). This reflects a trend of increasing walnut production in recent years (Vahdati, 2000). The Iran plateau has been regarded as the site of origin of the *Juglans regia* species in some literature and thus, this species is named "Persian walnut" (Leslie and McGranahan, 1998). Large populations of *Juglans regia* exist in this region, and most of them are seedlings and notably variable in production and nut quality (Germain, 1993; Ozkan et al., 2001; Reil et al., 1998; Stanisavljevic and Mitrovic, 1997). Selections of promising walnut cultivars in these populations along with the market demand for better quality products have increased interest in vegetative propagation of this species (Ferhatoglu, 1997; Vahdati, 2003).

Walnut trees are more difficult to graft than most fruit trees (Dhuria et al., 1977; Kuden and Kaska, 1997; Ozkan and Gumus, 2001) and poor graft take has always been considered a drawback in mass propagation of superior walnut selections (Ozkan et al., 2001; Roghani, 1977; Vahdati, 2003).

Environmental conditions during and after grafting, have a major impact on callus formation in walnut (Avanzato and Atefi, 1997; Rongting and Pinghai, 1993; Sitton, 1931). Optimally, the temperature should be maintained at about 27°C after grafting for better callus formation and graft success in walnut (Avanzato and Atefi, 1997; Germain, 1998; Reil

et al., 1998; Sen, 1986; Sitton, 1931). Accordingly, outdoor grafting is always restricted by the time of year when such favorable temperatures can be expected (Karadeniz, 2005; Kuden and Kaska, 1997; Hartmann et al., 2001). Different techniques of grafting have been examined by several researchers to improve the temperature and humidity effects by using controlled environmental conditions (Achim and Botu, 2001; Atefi, 1997; Avanzato, 2001; Avanzato and Atefi, 1997; Avanzato and Tamponi, 1987; Ferhatoglou, 1997; Lagerstedt, 1981; Lantos, 1990), however, most of these methods were inefficient, expensive, and not applicable on a large scale. Thus, existing procedures need improvement to allow efficient walnut propagation in nontraditional months of a year.

The objective of this study was to compare the efficiency of walnut budding under greenhouse versus field conditions for producing budded walnut plants in different months of a year and in different areas than those currently in use and to characterize the performance of different techniques of budding under controlled conditions in different genotypes.

MATERIALS AND METHODS

To compare the effects of different grafting methods and genotypes under greenhouse and outdoor conditions, two experiments were conducted in Neiriz, Fars province, Iran. In the first experiment, three types of budding, including patch, shield and chip were investigated under greenhouse versus field conditions using a selection named N1 during June 2004. In the second experiment, the performance of patch and shield budding were compared in different selections under greenhouse conditions. Scion buds were taken from five local selections (named N1, N2, N3, N4 and N5) which have been chosen from among 1000 trees in Neiriz, Fars province, Iran. All of the selections were lateral bearing and their kernel percentage was between 48 and 54%.

The top of the rootstocks was cut back at three stages. At first, the rootstock was partially cut back to about 10 cm above the bud, leaving about 5-6 leaves above the scion bud. Fifteen days after budding, the rootstock was cut back to two leaves above the graft union. The last cut back was done after bud burst leaving 8-10 cm above the bud scion to help prevent the new shoots from dieing back.

Since temperature and humidity have crucial effects on the healing process, they were recorded during the experiment using a maximum-minimum thermometer and a hygrometer, respectively (Figures 1 and 2).

FIGURE 1. Trend of daily temperatures 3 weeks after budding under field and greenhouse conditions.

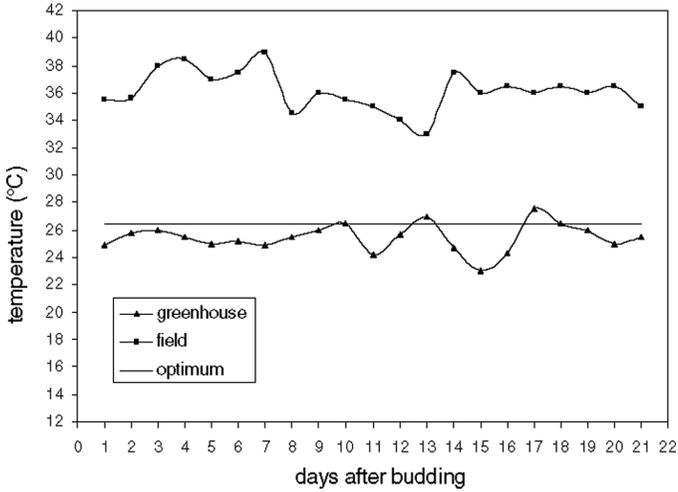
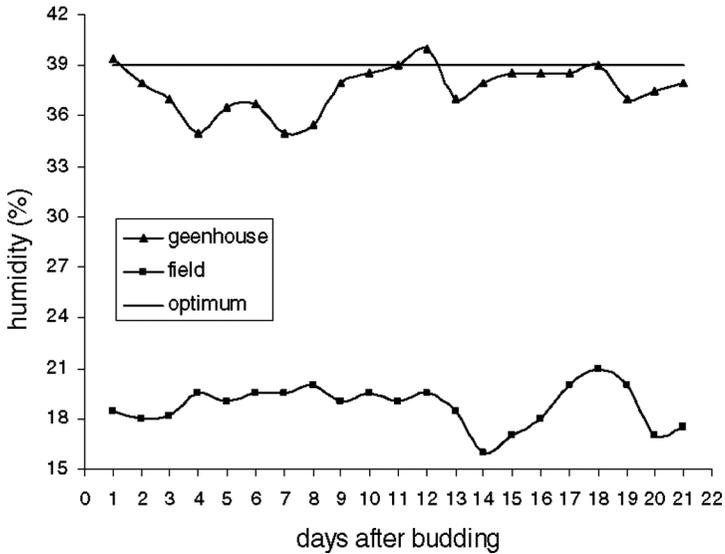


FIGURE 2. Trend of daily humidity 3 weeks after budding in field and greenhouse condition.



The mean temperatures in the greenhouse during the day and night were 25°C and 21°C and the mean relative humidity were 39 and 70%, respectively. These conditions were maintained in the greenhouse for 3 weeks after budding in. Humidity was controlled using watering the plants and surfaces during the day. The greenhouse roof surface was painted using the clay soil to reduce light received by the budded plants.

Field (outdoor) mean temperature was 32°C during the day and 17°C at night and relative humidity was 19 and 30% during the day and night of callusing process, respectively (Figures 1 and 2). To reduce direct light and temperature effects on the graft unions in the field, budding was done on the north-west side of the rootstocks. The top of the rootstocks were also bent on the junction portion to reduce light penetration. Light intensity ranged between 3,000 and 5,000 lux during the day in the greenhouse.

In the first experiment, data were combined and analyzed on the basis of a completely randomized design; and in next experiment, data were compared as a factorial experiment on the basis of completely randomized design. Statistical analyses were conducted using the SAS (SAS Institute, Cary, NC), and means were compared by least significant difference (LSD) at 0.05.

RESULTS AND DISCUSSION

Effect of Grafting Methods and Conditions

Interactions of graft type \times condition were significant, excluding for rootstock diameter. Thus, graft type \times condition interaction effects were compared using LSD method (Table 1). Rootstocks diameter did not show any significant difference, indicating the homogeneity of rootstocks in this experiment.

Percentages of “bud-take” were affected by different methods of budding under both conditions. The success rate of patch, shield and chip budding were 91, 31 and 19% in greenhouse versus 25, 15 and 10% under field conditions, respectively (Table 1). Under both greenhouse and field conditions, bud-take was highest using patch budding as compared with the shield and chip methods. Unal (1992) and Kaska et al. (1993) also obtained the highest success using patch budding. Lower bud-take of shield and chip budding could be related to less contact of the scion cambium with the rootstock bark cambium (Hartmann et al., 2001). We obtained a 19% bud-take success under greenhouse conditions

TABLE 1. Effect of different budding methods on callus formation, scion growth and grafting success percentage of N1 walnut selection under greenhouse (indoor) and field (outdoor) conditions.

| Graft type | No. grafted plants | No. successful grafts | Callus formation ^x (0-3) | Rootstock diameter (cm) | Scion growth (cm) | Successful grafting (%) |
|----------------|--------------------|-----------------------|-------------------------------------|-------------------------|-------------------|-------------------------|
| <i>Indoor</i> | | | | | | |
| Patch | 178 | 162 | 2.87a ^y | 1.13a | 8.18a | 91.0a |
| Shield | 161 | 50 | 2.00c | 1.62a | 2.77b | 31.1b |
| Chip | 157 | 30 | 1.60e | 1.20a | 2.50b | 19.1d |
| <i>Outdoor</i> | | | | | | |
| Patch | 400 | 100 | 2.83b | 1.32a | 3.45b | 25.0c |
| Shield | 400 | 60 | 1.80d | 1.38a | 3.10b | 15.0d |
| Chip | 100 | 10 | 1.00f | 1.29a | 1.80b | 10.0e |

^xCallus formation rating from 1 (little callus) progressively to 3 (very good callus).

^yMeans with the same letter in each column are not significantly different.

Note: Mean separation within column by LSD at $P = 0.05$.

with chip budding which is in agreement with Gautman (1990). Patch budding success under field conditions was 25%, whereas Kuden and Kaska (1997), Gautman (1990), Nasiri (1994), Atefi and Mostafavi (1983) and Karadeniz (2005) reported a 50, 35, 55, 50 and 29-64% success rate, respectively. Variation in the success rate could be due to various environmental conditions in different areas (Figures 1 and 2).

Callus formation was higher under greenhouse conditions compared with outdoors using all budding methods. Patch budding produced the best callus formation and scion growth followed by shield and chip budding under both conditions (Table 1). Temperature and humidity have a pronounced effect on the production of callus tissue, which is essential for good graft union formation (Hartmann et al., 2001; Karadeniz, 2005; Vahdati and Zareie, 2006). Callus formation generally takes place between 4°C and 32°C; although maximum callusing in walnut has been reported at 26.5°C (Sitton, 1931) (Figure 1). Unal (1992) and Li et al. (1984) reported the highest walnut graft success at 27.8°C. In addition, since the parenchyma cells comprising the callus tissue are thin-walled and tender, they have no protection against desiccation, which is caused by low relative humidity and direct sunlight, and get readily injured (Hartmann et al., 2001). The results indicate that controlling temperature and humidity to around the optimum for callusing in greenhouse (Figures 1 and 2) improves the budding success. This confirms the results

of our previous work (Dhuria et al., 1977; Sharma and Dhuria, 1981; Vahdati and Zareie, 2006).

There is also evidence that high intensity light prevents callus formation (Hartmann et al., 2001). Under greenhouse conditions, painting the roof surface using the clay soil reduced light irradiance to 3,000-5,000 lux during the days and helped to maintain suitable temperature and humidity. Whereas high intensity sunlight, high daytime temperatures, and low humidity during late spring and early summer caused poor callusing in the field experiment. This is in agreement with Kuden and Kaska (1997) and Hartmann et al. (2001) who suggest that walnut budding be undertaken in late summer under field conditions found in subtropical regions to reduce adverse conditions.

Effect of Genotype

In the second experiment, graft type \times genotype interaction effects were significant for callus formation and rootstock diameter. Therefore, the interactions of graft type and genotype were compared using the LSD method (Table 2). Selections did not show significant differences in graft success using patch and shield budding, excluding the N3 selection

TABLE 2. Influence of walnut selections on callus formation, scion growth and grafting success percentage using patch and shield budding under greenhouse conditions.

| Variety | No. grafted plants | No. successful grafts | Callus formation ^x (0-3) | Rootstock diameter (cm) | Scion growth (cm) | Successful grafting (%) |
|---------------|--------------------|-----------------------|-------------------------------------|-------------------------|-------------------|-------------------------|
| <i>Patch</i> | | | | | | |
| N1 | 178 | 162 | 2.87b ^y | 1.13a | 8.18b | 91.0a |
| N2 | 153 | 131 | 3.00a | 1.31a | 9.53a | 86.3a |
| N3 | 180 | 162 | 2.93b | 1.13a | 8.46ab | 90.0a |
| N4 | 141 | 121 | 2.92b | 1.15a | 8.47ab | 85.1a |
| N5 | 136 | 128 | 2.98a | 1.37a | 9.63a | 88.2a |
| <i>Shield</i> | | | | | | |
| N1 | 100 | 50 | 2.00d | 1.62a | 2.77c | 30.0c |
| N2 | 75 | 30 | 1.80e | 1.18a | 3.37c | 40.0c |
| N3 | 55 | 30 | 2.63c | 0.87a | 2.60c | 54.5b |
| N4 | 94 | 30 | 1.90de | 0.98a | 3.70c | 31.9c |
| N5 | 161 | 30 | 1.90de | 0.95a | 2.59c | 31.1c |

^xCallus formation rating from 1 (little callus) progressively to 3 (very good callus).

^yMeans with the same letter in each column are not significantly different.

Note: Mean separation within column by LSD at $P = 0.05$.

which had the highest graft success using the shield budding. Grafting success of N1 was the highest (91%) and N4 was the lowest (85%) using patch budding in comparison with N3 (54.5%) and N1 (30%) using shield budding under greenhouse conditions (Table 2). Rootstock diameter at 5 cm above the crown was not significantly different in the selections, which indicates homogeneity of rootstock in this experiment. Scion growth after 45 days was the highest using patch budding compared with shield budding in all studied selections, which was related to earlier scion bud sprouting in patch budded plants. Scion growth of the selections was not significantly different for shield budding. However, the N1 selection had significantly lower scion growth compared to the N2 and N5 selections. According to the results of other researchers, bud-take percentage usually varies in different walnut selections (Kuden and Kaska, 1997; Stanisavljevic and Mitrovic, 1997), which is consistent with the obtained results in our experiment.

CONCLUSIONS

Favorable temperature and humidity are essential for callus development in walnut grafting; however, these factors are not usually favorable outdoors during many months of the year. Therefore, controlling temperature and humidity could have a major impact on walnut grafting success. Under greenhouse conditions we could control diurnal temperatures and relative humidity to meet the requirements for optimum callusing of the grafts. Our results also suggest that patch budding produces better callusing, scion growth and bud-take as compared with shield and chip budding. Therefore, we recommend producing grafted walnut plants using patch budding under greenhouse conditions for avoiding adverse outdoor conditions. This technique is also economically promising and allows for expansion into new areas and for propagation during nontraditional months.

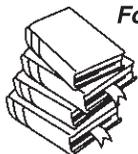
LITERATURE CITED

- Achim, G. and I. Botu. 2001. Results in walnut propagation using different methods. *Acta Hort.* 544: 503-509.
- Atefi, J. 1997. Comparison of hypocotyle and hot callus cable graft with traditional grafting method. *Acta Hort.* 442: 309-312.

- Atefi, J. and M. Mostafavi. 1983. Patch budding of walnut trees. Seed and Plant Improvement Institute Pub., Iran.
- Avanzato, D. 2001. Effect of different hygro-thermic environments on growth of potted walnut grafted seedlings. *Acta Hort.* 544: 459-464.
- Avanzato, D. and G. Tamponi. 1987. The effect of heating of walnut graft unions on grafting success. *Acta Hort.* 227: 79-83.
- Avanzato, D. and J. Atefi. 1997. Walnut grafting by heating the graft-point directly in the field. Walnut grafting by heating the graft-point directly in the field. *Acta Hort.* 442: 291-294.
- Dhuria, H.S., V.P. Bhutani, and R.P. Dhar. 1977. Standardization of propagation techniques in walnut. I. Preliminary studies on grafting. *Ind. J. Hort.* 34: 20-23.
- F.A.O. 2005. Statistics. www.fao.org.
- Ferhatoglou, Y. 1997. The studies on the effect of potting and omega grafting in relation to different time on graft taking percents of some standard walnut varieties. *Acta Hort.* 442: 303-308.
- Gautman, D.R. 1990. Studies on the winter and summer vegetative propagation techniques of walnut (*Juglans regia*). *Acta Hort.* 284: 27-31.
- Germain, E. 1993. The Persian walnut in Iran. *Nucis Newsletter.* 1: 5-6.
- Germain, E. 1998. Production and economics of nut crops. Advanced course, May 18-29, Adana, Turkey.
- Hartmann, H.T., D.E. Kester, F.T. Davies, and R.L. Geneve. 2001. *Plant Propagation: Principles and Practices.* 7th edition. Prentice Hall International, Inc. NJ.
- Karadeniz, T. 2005. Relationships between graft success and climatic values in walnut (*Juglans regia* L.). *J. Central European Agr.* 6: 631-634.
- Kaska, N., A. Kuden, and N. Turemis. 1993. Walnut growing activities at Taurus Mountains in Turkey. *Acta Hort.* 311: 37-40.
- Kuden, A. and N. Kaska. 1997. Studies on the patch budding of walnuts in different budding periods under subtropical conditions. *Acta Hort.* 442: 299-301.
- Lagerstedt, H.B. 1981. A new device for hot callusing graft unions. *HortScience.* 16: 529-530.
- Lantos, A. 1990. Bench grafting of walnut. *Acta Hort.* 284: 53-56.
- Leslie, C.A. and G.H. McGranahan. 1998. The origin of walnut, pp. 3-7. In: D. Ramos (ed.), *Walnut Production Manual.* University of California, DANR Publ., Davis.
- Li, S.Y., T.Y. Yan, and D.P. Fu. 1984. An experiment on walnut bud grafting in the open. *J. Experimental Station of Forestry Sciences, Jiyuan County, Henan, China.* 3.
- Nasiri, M. 1994. Propagation of Persian walnut through grafting. *Pajouhesh va Sazandegi.* 22: 12-14.
- Ozkan, Y. and A. Gumus. 2001. Effects of different applications on grafting under controlled conditions of walnut. *Acta Hort.* 544: 515-520.
- Ozkan, Y., Y. Edizer, and Y. Akca. 2001. A study on propagation with patch budding of some walnut (*Juglans regia* L.) cultivars. *Acta Hort.* 544: 521-526.
- Reil, W.O., C.A. Leslie, H.I. Forde, and J.R. McKenna. 1998. Propagation, pp. 71-83. In: D. Ramos (ed.), *Walnut Production Manual.* University of California, DANR Publ., Davis.
- Roghani, M.S. 1977. Propagation of walnut by grafting. *J. Agric. Res.* 4: 389-392.

- Rongting, X. and D. Pinghai. 1993. A study on the uniting process of walnut grafting and the factors affecting. *Acta Hort.* 311: 160-170.
- Sen, S.M. 1986. Walnut growing. ESER Publication. Samsun. 229 pp.
- Sharma, S.H. and H.S. Dhuria. 1981. Standardization of suitable media and the interval for walnut propagation under controlled conditions. *Prog. Hort.* 13: 43-46.
- Sitton, B.G. 1931. Vegetative propagation of the black walnut. *Mich. Agr. Exp. Sta. Tech. Bul.* 119.
- Stanisavljevic, M. and M. Mitrovic. 1997. Effect of variety on successful grafting and development of nursery trees of walnut (*Juglans regia* L.). *Acta Hort.* 442: 281-284.
- Unal, A. 1992. Studies on the effects of different practices on grafting success in bark, whip and top-cleft grafting in walnuts. *Hort Abst.* 66: 9329.
- Vahdati, K. 2000. Walnut situation in Iran. *Nucis Newsletter.* 9: 32-33.
- Vahdati, K. 2003. Nursery Management and Grafting of Walnut. *Khaniran Publ., Tehran.*
- Vahdati, K. and N. Zareie. 2006. Evaluation of side-stub and hypocotyle grafting efficiency for walnut propagation in Iran. *Acta Hort.* 705: 347-350.

doi:10.1300/J492v06n04_02



For FACULTY/PROFESSIONALS with journal subscription recommendation authority for their institutional library . . .

If you have read a reprint or photocopy of this article, would you like to make sure that your library also subscribes to this journal? If you have the authority to recommend subscriptions to your library, we will send you a free complete (print edition) sample copy for review with your librarian.

1. Fill out the form below and make sure that you type or write out clearly both the name of the journal and your own name and address. Or send your request via e-mail to docdelivery@haworthpress.com including in the subject line "Sample Copy Request" and the title of this journal.
2. Make sure to include your name and complete postal mailing address as well as your institutional/agency library name in the text of your e-mail.

[Please note: we cannot mail specific journal samples, such as the issue in which a specific article appears. Sample issues are provided with the hope that you might review a possible subscription/e-subscription with your institution's librarian. There is no charge for an institution/campus-wide electronic subscription concurrent with the archival print edition subscription.]

YES! Please send me a complimentary sample of this journal:

_____ (please write complete journal title here—do not leave blank)

I will show this journal to our institutional or agency library for a possible subscription.

Institution/Agency Library: _____

Name: _____

Institution: _____

Address: _____

City: _____ State: _____ Zip: _____

Return to: Sample Copy Department, The Haworth Press, Inc.,
10 Alice Street, Binghamton, NY 13904-1580