Implementation of Bar-code Technology in a Tree Fruit Breeding Program

Kate M. Evans¹, Lisa J. Brucher, and Bonnie S. Konishi

Washington State University Tree Fruit Research and Extension Center, 1100 N. Western Ave, Wenatchee, WA 98801

Additional index words. inventory, apple breeding, sample tracking

Abstract. Inventory control of trees and fruit samples in the Washington State University apple breeding program has been simplified by the use of bar codes. Tree labels incorporate individual bar-coded identities that can be scanned in the field when taking measurements or collecting samples. Bar codes on fruit sample labels also simplify data recording as well as improve the efficiency of the program by greatly reducing the risk of errors. The interface of bar-code identities with data organization and statistical software makes data analysis more straightforward.

To be successful, a breeding program has to be able to track all its seedlings at every stage of testing and to ensure that the origin of each seedling product (e.g., fruit) tested is correctly recorded. The Washington State University apple breeding program (WABP) has more than 30,000 genotypically unique fruiting trees in the evaluation orchard at any one time. In a typical year, ≈2500 fruit samples are evaluated from August through February. Typically, breeding progeny are given a unique identifier name with a string of up to 17 characters including letters, numbers, and symbols; labeling or data entry errors are almost inevitable. Frequently, a mere transposition of two characters in a name can produce another name that is equally credible but erroneous and is not easily noted when checking data. Errors in tracking samples back to the tree can prove costly (both in terms of time and money), particularly if the wrong individual is propagated for multisite trials or, worse, for release.

Application

After planting, labels (TX10775 Slip-on end-to-end tree labels; Sato America Inc., Charlotte, NC) are printed (Zebra S4M Industrial Bar Code Printer; Zebra Technologies Corporation, Lincolnshire, IL) for each tree with the unique identifier in both regular and bar-code fonts (Palmer, 1995). Trunk diameters of advanced selection trees are recorded along with fruit yield for the standardized measure of yield efficiency to be

calculated. Electronic calipers (Fowler Ultra-Cal III; Fowler Co., Inc., Newton, MA) attached directly to handheld data loggers with bar-code readers (Allegro MX; Juniper Systems, Logan, UT) minimize the opportunity for error.

At harvest, the data logger with bar-code reader is used to scan the bar codes on the tree labels. Fruit is harvested into a bag, which is labeled with a self-adhesive bar-code label printed by a small printer (QL220 plus mobile printer; Zebra Technologies Corporation), which can be clipped to either a belt or a picking bag if required and connects through Bluetooth™ to the data logger. The bar code on the fruit label includes the tree identity and the harvest date, because samples are usually picked more than once from the same tree to ensure assessment at optimum maturity. Once in the quality assessment laboratory, fruit samples are divided into 10-fruit subsamples for immediate assessment and post-storage assessment and a bar-coded label is produced to distinguish each sample.

Five of the fruit from each sample are then assessed instrumentally for quality and five are reserved for sensory analysis. The Mohr® DigiTest (Mohr and Associates, Richland, WA) is used to measure firmness and texture (Evans et al., 2010); a bar-code scanner is used to directly input the sample name into the DigiTest. Starch levels using the Cornell chart (Blanpied and Silsby, 1992) are recorded on slices of fruit sprayed with iodine solution; a bar-coded label and the handheld data logger are used to record the ratings into

a Microsoft Excel (Microsoft, Redmond, WA) spreadsheet. The remainder of the fruit is juiced and again the samples are labeled with the self-adhesive bar-coded label. Bar-code scanners are used to input the sample records into the digital refractometer (RX-5000α; Atago, Bellevue, WA) for measurement of soluble solids (sweetness) content and the autotitrator (Titrand; Metrohm, Riverview, FL) for malic acid determination (tartness). Output from each of these instruments can be readily saved in Excel, making further manipulation and statistical analysis straightforward.

The WABP team rates the remaining five fruit for a range of appearance and sensory descriptors. The bar-coded label from each fruit sample is transferred to the score sheet to facilitate data entry.

Conclusion

The application of bar codes to the WABP has greatly reduced the potential for errors as well as the tedium of data entry. Data are also readily available for further statistical analysis. Use of bar codes is now routine in many laboratories and other field experimental programs (Ampatzidis and Vougioukas, 2009; Kuti et al., 2004), but the wider application to tree fruit breeding programs has not been reported to the best of our knowledge. These techniques for managing tree fruit samples have obvious advantages for any form of variety testing, scion or rootstock, or management of germplasm collections as well as for a breeding program.

Literature Cited

- Ampatzidis, Y.G. and S.G. Vougioukas. 2009. Field experiments for evaluating the incorporation of RFID and barcode registration and digital weighing technologies in manual fruit harvesting. *Comput. Electron. Agr.* 66:166–172.
- Blanpied, G.D. and K. Silsby. 1992. Predicting harvest date windows for apples. *Info. Bul.* 221. Cornell Univ., Ithaca, NY.
- Evans, K.M., L.J. Brucher, B.S. Konishi, and B.H. Barritt. 2010. Correlation of sensory analysis with physical textural data from a computerized penetrometer in the Washington State University apple breeding program. *HortTechnology* 20:1026–1029.
- Kuti, C., L. Lang, and Z. Bedo. 2004. Use of barcodes and digital balances for the identification and measurement of field trial data. *Acta Agronomica Hungarica*. 52:409–419.
- Palmer, R.C. 1995. The bar code book: Reading, printing, and specification of bar code symbols. 3rd Ed. Helmers Publishing. p. 386.

Received for publication 1 Sept. 2011. Accepted for publication 27 Nov. 2011.

This work was partially funded by the Washington Tree Fruit Research Commission (WTFRC).

We thank Ron Campbell and Amy Hansen, Juniper Systems, for assistance in setting up the bar-code technology.

¹To whom reprint requests should be addressed; e-mail Kate_evans@wsu.edu.