Antibiotic Residues and Use Patterns on Apples and Pears

WASHINGTON STATE UNIVERSITY EXTENSION FACT SHEET • FS137E

Introduction

The use of antibiotics in agriculture is under scrutiny due to concerns about the potential for development of resistance to medical antibiotics by human pathogens. Predominant agricultural uses of antibiotics are in animal production systems, however there are several minor but important uses in plant agriculture to control bacterial diseases. In 2009, these plant uses accounted for about 0.1% of the total agricultural use of antibiotics in the United States in terms of pounds of active ingredient (Stockwell and Duffy 2012). Thus, use of antibiotics for the prevention of plant diseases is a minor use compared to the other non-clinical uses of antibiotics.

Fire blight, caused by the bacterium *Erwinia amylovora*, is an economically important disease of apples and pears in Washington State and across the country, and control of fire blight accounts for a significant share of current antibiotic use on plants. For the past several decades, oxytetracycline (OTC) and streptomycin have been the primary control materials for the disease during bloom, when disease models indicate high risk of infection. Both of these antibiotics are used in human medicine as well, and certain advocacy groups have called for their elimination from agricultural use. In addition, both antibiotics have been allowed for control of fire blight on organic apples and pears under the National Organic Program, but are slated for phase-out in October 2014. Part of the argument for eliminating the use of antibiotics for fire blight control has been based on unsubstantiated claims about the presence of antibiotic residues on or in the fruit after harvest.

Antibiotic use patterns for fire blight control

Streptomycin has been used commercially to control plant diseases in the U.S. since the 1950s. OTC was registered as an alternative to streptomycin on pears in 1974 when streptomycin-resistant fire blight bacteria were discovered in pear orchards in California due to frequent use of this material. Streptomycin resistance in *E. amylovora* was then documented in Pacific Northwest orchards, and in the past decade it has become increasingly common in orchards in New York.

Use of OTC was allowed for apple production under an emergency exemption by the U.S. Environmental Protection Agency (EPA), beginning in 1991 and continuing until November 2007, when a Section 3 registration was approved and a tolerance was established for its use on apples. Populations of *E. amylovora* resistant to field rates (100 ppm and greater) of OTC have not been detected in orchards in the Pacific Northwest (V. Stockwell, pers. comm.) or other regions of the U.S., to date.

Data on antibiotic use on apples and pears have been collected every other year by the USDA National Agricultural Statistics Service (NASS) Agricultural Chemical Usage survey since 1991 (Figure 1). On average, 10.5% of apple acres in the U.S. were treated with OTC and 16.6% with streptomycin annually between 2001 and 2011 (USDA-NASS undated). The acreage of pears treated annually with OTC in the Pacific Northwest averages closer to 30%. In 2007 only, data were collected separately for organic apples and pears. In that year, 5% of organic apple acres were treated with OTC, compared to 7% of conventional apple acres. In 2012, the Washington State Department of Agriculture's Organic Food Program examined its records of organic apple and pear growers and found that 76 of 333 growers (23%) used OTC that year, a year with severe fire blight risk. The percentage of acres treated was not calculated. During the preceding decade, an estimated 10 to 20% of Washington organic tree fruit growers were enrolled in the EU compliance program for exporting fruit to Europe. This required no use of antibiotics for the previous three years. A 2012 informal survey of organic apple growers in New York—many of whom had small-scale operations—found that about 90% of those growers did not use antibiotics and did not plan to. Lack of effective fire blight control has been cited as a major barrier to expansion of organic apple and pear production in East Coast states.

Clearly, claims by consumer groups (Wright 2013) that every organic apple and pear (and by extension, every apple and pear from conventional orchards) contains residues of both antibiotics used for fire blight control are false and misleading, because the majority of acres of these crops are not treated with antibiotics in most years. Growers currently rely on predictive disease models such as CougarBlight or MaryBlyt to guide their decisions about

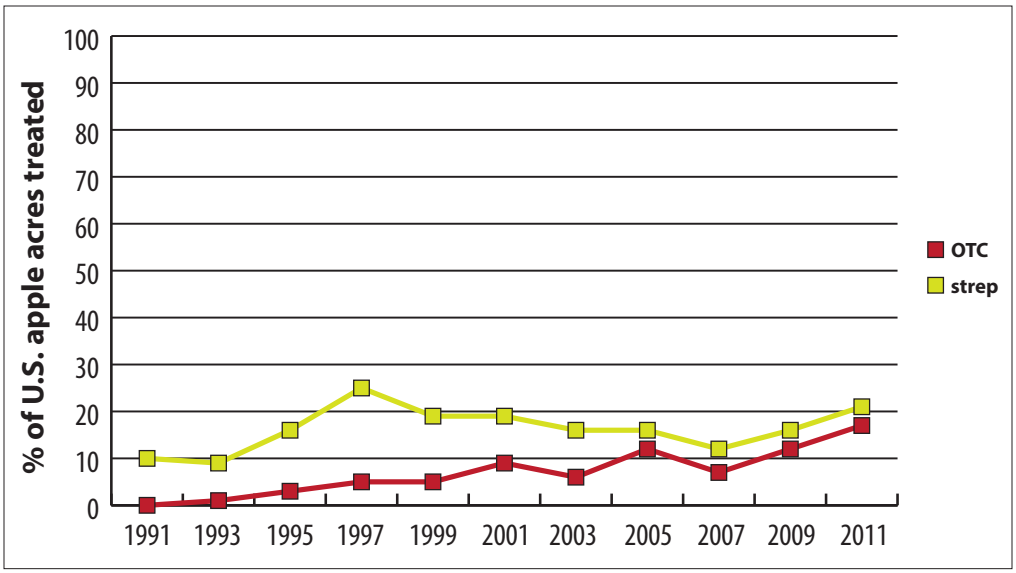

Figure 1. Percent of U.S. apple acres treated with antibiotics oxytetracycline (OTC) or streptomycin (strep) based on the USDA-NASS Agrichemical Use Survey.

whether to use an antibiotic treatment, based on weather conditions and the history of fire blight in the orchard and area.

Fate of antibiotics in the orchard

Many studies have examined streptomycin residues on apple and pear trees, while fewer have addressed residues of OTC. Residue tolerance levels on tree fruit crops are set at 0.25 ppm for streptomycin (U.S. EPA 2006) and 0.35 ppm for OTC (U.S. EPA 2005). Both antibiotics lose their effectiveness within a matter of days in an orchard environment. Their rapidly diminished activity on plant surfaces is due to various mechanisms such as degradation by sunlight, wash-off by rain, and binding with soil particles. Even on trees protected from rain and sunlight, antibiotics lost their ability to inhibit *E. amylovora* after 4 days, despite remaining at levels detectable through sensitive chemical analysis (Stockwell et al. 2008).

Tetracycline applied to soil via animal manure in a field experiment was bound to soil particles and deactivated within 24 hours (Subbiah et al. 2011). Thus, it was considered by the authors to be a low-risk antibiotic for selecting for resistance in human pathogens in the ambient environment. Overall, research on antibiotic residues on fruit at harvest has found either none detectable or levels detected at well below the tolerances set by government agencies (see Stockwell et al. 2013).

Residue data for streptomycin and OTC are not collected as part of the residue monitoring done by federal or state agencies such as the USDA-AMS Pesticide Data Program. Thus, little data exist regarding residues from normal use on fruit near the point of consumption.

In 2012, a preliminary study was conducted with apples from 7 different orchards in central Washington treated with one to five applications of OTC at label rate (200 ppm, 100 gal/ac). Applications were made during the bloom and immediate post-bloom periods in all but one orchard, where a single summer application was made in July (in addition to bloom applications) because of hail damage on a fire-blight-susceptible cultivar. Fruit samples (8–15 fruit per site) were collected from the orchards in early November and tested for OTC using LC-MS-MS (considered one of the most sensitive analytical methods). The limit of quantification was 0.01 ppm, and the estimated limit of detection was <0.001 ppm. No residues were detected on the fruit from any of the orchards (Granatstein 2013).

Additional testing was done by the Washington State Department of Agriculture Organic Food Program on the 2013 crop. Between Sept. 18 and Oct. 3, 2013, 21 apple and 2 pear samples (5–10 fruit per site, composited) were collected from orchards throughout central Washington (7 different counties) that had been treated with OTC during the growing season. All apple samples were treated during bloom or shortly thereafter. The two pear samples were gleaned from an orchard treated to prevent fire blight infection following a late summer hail storm which occurred after commercial harvest of the crop was complete. The orchard had been treated less than 30 days prior to sampling, and no treated pears were harvested for consumption. Analysis was done for OTC at the WSDA Plant Protection Laboratory in Yakima, WA, using LC-MS-MS, with a Minimum Detection Limit and Limit of Quantification of 0.0106 ppm.

All apple samples came back Non-Detectable for OTC (WSDA unpublished data). Pear samples showed residues of 0.15 and 0.066 ppm, due to the short interval between application and sampling, which was less than the 60-day pre-harvest interval specified on the label. It is noteworthy that the quantified residue of OTC on pear fruit sprayed directly with the antibiotic just 30 days prior to sampling was still less than the permissible residue level of 0.35 ppm. Considering the results of both trials, there is no evidence to indicate that residues of OTC would be detected on harvested fruit from trees treated with OTC in spring or early summer.

Conclusion

While extensive data on antibiotic residues on harvested apples and pears under normal use patterns are very scarce, the existing data, along with research results on the environmental fate of streptomycin and oxytetracycline and the documented percentage of acreage treated, suggest that most apples and pears at harvest—both organic and conventional—will be free of detectable residues of these antibiotics used to control fire blight. No fruit have been found to exceed the tolerances set by government agencies, and, when detected, residue levels are consistently well below the tolerance level. Recent testing of fruit treated under normal use patterns did not detect any OTC residues. A more robust study of residues of both antibiotics that includes different use rates and dates is warranted to provide further research-based data on the fate of these materials and their presence or absence in the fruit that consumers eat.

References

Granatstein, D. 2013. Oxytetracycline residue study. *In* Fire blight control in organic apples and pears web page. http://www.tfrec.wsu.edu/pdfs/P2817.pdf.

Stockwell, V.O. and B. Duffy. 2010. Use of antibiotics in plant agriculture. *Revue Scientifique et Technique* (International Office of Epizootics) 31:199–210.

Stockwell, V.O., D. Granatstein, and M. Grieshop. 2013. Antibiotic residues on plant tissues. Review document, Fire blight control in organic apples and pears web page. http://www.tfrec.wsu.edu/pdfs/P2632.pdf.

Stockwell, V.O., T.N. Temple, K.B. Johnson, and J.E. Loper. 2008. Integrated control of fire blight with antagonists and oxytetracycline. *Acta Hort.* 793:383–390.

Subbiah, M., S.M. Mitchell, J.L. Ullman, and D.R. Call. 2011. β-lactams and florfenicol antibiotics remain bioactive in soils while ciprofloxacin, neomycin, and tetracycline are neutralized. *Applied Environ. Microbiol.* 77:7255-7260.

U.S. Department of Agriculture-National Agricultural Statistics Service (USDA-NASS). Undated. Agrichemical Use Program database search. http://www.nass.usda.gov/Surveys/Guide_to_NASS_Surveys/Chemical_Use/.

U.S. Environmental Protection Agency (EPA). 2005. Oxytetracycline. Section 3 Use on Apples. Summary of Analytical Chemistry and Residue Data. HED Records Center Series 361 Science Reviews, File R104981. Environmental Protection Agency, Washington, DC. http://www.epa.gov/pesticides/chem_search/cleared_reviews/csr_PC-006304_3-Jan-05_a.pdf.

U.S. Environmental Protection Agency (EPA). 2006. Report of the Food Quality Protection Act (FQPA) tolerance reassessment progress and risk management decision (TRED) for streptomycin. Available at: www.epa.gov/oppsrrd1/REDs/streptomycin_tred.pdf.

Wright, C. 2013. Antibiotic Use On Organic Apples and Pears Proves Unnecessary -- Here's How to End the Madness and Protect Yourself. Organic Consumers Assoc., Finland, MN. http://www.organicconsumers.org/articles/article_27214.cfm.

WASHINGTON STATE UNIVERSITY EXTENSION

By **David Granatstein**, Sustainable Agriculture Specialist, Center for Sustaining Agriculture and Natural Resources/Tree Fruit Research and Extension Center, Washington State University, Wenatchee, WA; **Timothy Smith**, Regional Extension Specialist, Washington State University Extension, Wenatchee, WA; and **Dr. Michael Willett**, Vice President for Scientific Affairs, Northwest Horticultural Council, Yakima, WA.

Issued by Washington State University Extension and the U.S. Department of Agriculture in furtherance of the Acts of May 8 and June 30, 1914. Extension programs and policies are consistent with federal and state laws and regulations on nondiscrimination regarding race, sex, religion, age, color, creed, and national or ethnic origin; physical, mental, or sensory disability; marital status or sexual orientation; and status as a Vietnam-era or disabled veteran. Evidence of noncompliance may be reported through your local WSU Extension office. Trade names have been used to simplify information; no endorsement is intended. Published May 2014.

FS137E