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Biological control adoption in western U.S. orchard systems: Results from grower surveys

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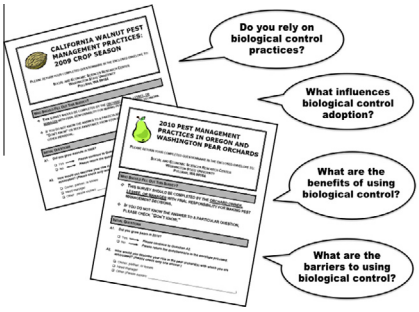
HIGHLIGHTS

- We conducted surveys of California walnut growers and Pacific Northwest pear growers.
- 54% of walnut growers and 76% of pear growers use one or more BC practices.
- Multiple factors influence growers' decisions to adopt BC practices.
- Adoption benefits include less pesticide use, environmental protection, and worker safety.
- Adoption barriers include lack of knowledge, perceived ineffectiveness, and high cost.

GRAPHICAL ABSTRACT



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ABSTRACT

As part of a USDA Specialty Crop Research Initiative project to enhance biological control (BC) in western U.S. orchard systems, we surveyed walnut growers in California and pear growers in Oregon and Washington about their pest management decision-making and use of BC practices. Seventy-six percent of pear growers and 54% of walnut growers reported using one or more BC practices. BC users were more likely to minimize factors that harm natural enemies than enhance natural enemy habitats or release commercially produced natural enemies. Walnut growers with more education and orchard experience, as well as larger and more diversified operations, were more likely to use BC practices. Walnut and pear growers with some certified organic acreage, who considered environmental impacts when making pest management decisions, and who used selected pest management practices (pheromone mating disruption and degree-day calculations for codling moth control) were more likely to use BC practices. BC users relied more heavily on industry publications and university-based sources of pest management information, compared with non-users. The perceived benefits of BC adoption included reduced reliance on pesticides, reduced production costs, environmental protection, protection of beneficial insects, and improved worker safety and human health. The perceived barriers to BC adoption included lack of knowledge, questionable effectiveness, high cost, and lack of recommendation by pest management consultants. Our research not only contributes to the literature on the adoption of sustainable agricultural practices, but also can inform future BC research and outreach by offering insight into who uses BC practices and assessment of perceived adoption benefits and barriers.

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1. Introduction

The U.S. Food Quality Protection Act (FQPA) of 1996 called for the reassessment of tolerances (maximum limits for pesticide residues in food) and reregistration of all pesticides on a regular cycle to assess risks to human health and the environment (EPA, 2015a). The FQPA led to significant reductions in the use of organophosphate (OP) pesticides, for example the phase-out of Guthion (azinphos-methyl) in 2001–2013 (EPA, 2015b). Because of FQPA-mandated changes, U.S. growers have increasingly relied on reduced risk (OP-alternative) pesticides and integrated pest management (IPM) approaches (Jones et al., 2009a,b, 2010; Van Steenwyk and Zalom, 2005). For example, the IPM programs used in western U.S. orchard systems now regularly combine the use of reduced risk pesticides with pheromone mating disruption and conservation biological control (BC) (Brunner et al., 2002; Goldberger et al., 2013; Jones et al., 2009a,b). While many studies have investigated the adoption of IPM strategies (see, e.g., Feder and Savastano, 2006; Fernandez-Cornejo et al., 1994; Grieshop et al., 1988; Kaine and Bewsell, 2008; Peshin et al., 2009; Ridgely and Brush, 1992; Thomas et al., 1990), few have focused specifically on the adoption of BC practices. In this paper, we focus on conservation BC (protection or enhancement of natural enemy habitats) and augmentative BC (release of commercially produced natural enemies to supplement natural populations).

A review of the literature shows that we lack a comprehensive understanding of who uses BC practices as well as growers' perceptions of the benefits and barriers to adoption of BC. It is essential for researchers, extension personnel, and policy makers who believe BC practices offer substantial environmental, economic, and social benefits to understand the factors that influence growers' decisions to adopt such practices (Perkins and Garcia, 1999). This is especially true given the recent regulatory and technological changes that have pushed growers to consider more IPM and BC options for orchard systems (Jones et al., 2009a,b, 2010; Goldberger et al., 2013).

For this study, we analyze the results from surveys of walnut growers in California and pear growers in Oregon and Washington (hereafter, Pacific Northwest) to better understand the factors that influence growers' decisions to use BC practices in western U.S. orchard systems. We also examine growers' perceptions of the benefits and barriers to using BC. The surveys were conducted as part of an interdisciplinary, multi-institutional USDA Specialty Crop Research Initiative (SCRI) project designed to enhance BC in western U.S. orchard systems. In this paper, we begin by reviewing the social science literature on BC, with particular emphasis on studies of the factors that influence growers' decisions to adopt BC practices. We then discuss our research methods, data analysis procedures, and significant findings.

2. Literature review

The social science research on BC can be grouped into four categories: (1) studies of the influences on growers' decisions to adopt BC practices (Abdollahzadeh et al., 2015; Brodt et al., 2004, 2006; Grogan, 2014; Grogan and Goodhue, 2012; Moser et al., 2008; Niyaki et al., 2010; Ommani and Noorivandi, 2012; Warner, 2007; Wawrzynski et al., 2001); (2) sociohistorical and political economic analyses of BC programs (Altieri, 1991; Altieri et al., 1997; Perkins and Garcia, 1999; van Lenteren, 2012; Warner et al., 2011; Warner and Getz, 2008); (3) public engagement and public opinion research on BC (McNeil et al., 2010; Warner, 2012; Warner et al., 2008); and (4) economic analyses of BC adoption (Cullen et al., 2008; Ervin et al., 1983; Griffiths et al., 2008; Jetter, 2005; Jetter et al., 1997; Jetter and Paine, 2004; Kipkoech et al., 2006; Myrick et al., 2014; Voegele, 1989; Zeddies et al., 2001). Given that we surveyed walnut and pear growers about their use of BC practices, our research contributes to the scholarly work on the influences of growers' decisions to adopt BC practices. We thus devote the majority of our literature review to category 1. However, we also provide brief summaries of categories 2–4 to cover the entirety of the social science literature on BC. To our knowledge, such a comprehensive review is lacking in the existing literature.

2.1. Influences on growers' decisions to adopt biological control practices

Despite decades of research on growers' adoption of IPM (see, e.g., Benbrook, 1996; Feder and Savastano, 2006; Fernandez-Cornejo et al., 1994; Grieshop et al., 1988; Kaine and Bewsell, 2008; Peshin et al., 2009; Ridgely and Brush, 1992; Thomas et al., 1990), only a limited number of studies have focused specifically on the factors that influence growers' decisions to adopt BC practices. Perkins and Garcia (1999) suggest that decisions to implement conservation BC, in particular, may be influenced by age, education, income, operation size, assessment of risk, faith in new technology, impacts on personal time, and implications for other parts of the operation; however, they do not present empirical data. The existing empirical research, typically involving surveys and in-depth interviews, tends to focus on grower demographics, operation characteristics, sources of agricultural information, participation in extension activities, knowledge of on-farm beneficial insects, and overall farm management style.

Wawrzynski et al. (2001) surveyed greenhouse operators in nine midwestern U.S. states to obtain information on the use of BC practices. Less than 10% of respondents used BC practices (predators or parasites) as part of their pest management programs. BC use was correlated with higher levels of education: 62% of BC users had a college degree or higher compared to 38% of non-users. BC use was not related to the size of the greenhouse operation, gross sales, or the number of employees.

Niyaki et al. (2010) studied the relationship between nine grower characteristics and the use of *Trichogramma* spp. (Hymenoptera: Trichogrammatidae) to control rice stem borer, *Chilo suppressalis* (Lepidoptera: Crambidae), among rice growers in northern Iran. Their data showed statistically significant (positive) relationships between *Trichogramma* use and four variables: education level, family size, years of experience in rice cultivation, and frequency of participation in educational and extension activities. Ommani and Noorivandi (2012) found that adopters and non-adopters of parasitic wasps (Hymenoptera: Braconidae) to control corn *Caradrina* (Lepidoptera: Noctuidae) in western Iran differed significantly in terms of education, income, farm size, level of mechanization, extension activities, social participation, and access to information. Also working in Iran, Abdollahzadeh et al. (2015) found that rice growers who were aware of the harmful effects of pesticides were more likely to be supportive of BC practices on their farms.

In their study of the use of biologically integrated farming practices among California almond and winegrape growers, Brodt et al. (2004, 2006) emphasize the importance of growers' beliefs, attitudes, and goals in farm management decision-making. They found that "environmental stewards" (growers who value the conservation of natural resources over high yields or profits) and "networking entrepreneurs" (growers who enjoy exchanging information about cutting-edge innovations with their peers and other experts) were more likely than "production maximizers" (growers who strive to produce the highest possible yields and crop quality) to use BC practices (Brodt et al., 2004).