Farmers' knowledge about common pests and pesticide safety in conventional cotton production in Pakistan

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ABSTRACT

Innovations in cotton (*Gossypium hirsutum* L.) pest management should be initially based on the perspective of cotton farmers, recognizing farmers' constraints and their existing technical knowledge as the basis for an effective collaboration. A survey of 318 randomly selected farmers from two districts of the cotton belt of Punjab in Pakistan was conducted to study common crop protection problems and related behaviors in cotton production in the area. Data were collected through group discussions with farmers and individual interviews. Relative frequencies of distribution for the tested variables, weighted average scores based on the weight assigned to each answer for the rating scales, and the Borich Needs Assessment Model for the training needs were used for relevant comparisons. Most farmers considered pest damage to be important in cotton production causing significant yield losses. Farmers had awareness of some major insect pests, but the majority of them used descriptive than specific names when defining a pest. Among well-known insects whiteflies, aphids, leafhoppers, thrips, and bollworms were mentioned, but farmers had great difficulty in distinguishing the different species. Identification of cotton diseases was practically non-existent, except from cotton leaf curl. Farmers were aware of a limited number of major weeds. Most of them stated purple nutsedge and bermudagrass as frequent weed problems in cotton production in the area. In general, weeds were perceived as a constant and unresolved problem in cotton production, but with less impact on yield than insects. The majority of the farmers relied on the chemical method for pest control, but knowledge on pesticide safety issues was below average. High needs for training were found on a) the proper period for pesticide application, b) the identification of natural enemies for cotton pests, and c) the discrimination of symptoms of various diseases. Understanding farmers' views of pests and their impact can be a first major step for more efficient pest management in cotton production.

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1. Introduction

Cotton (*Gossypium hirsutum* L.) cultivation is often highlighted for excessive consumption of plant protection products for pest control (Deguine et al., 2008; Damalas and Hashemi, 2010). Insects are a major constraint to efficient cotton production worldwide and a serious problem, particularly for resource-poor smallholder farmers in many developing countries; insect control in cotton imposes high costs which can lead to environmental problems (Fitt, 2000). Plant pathogens may be also harmful in some areas and

years, but are regarded of minor importance (Oerke, 2006). Cotton plants are also affected by weed competition mostly in the vegetative stages. Despite continuous improvement in the performance of chemical control strategies, harvest losses remain quite high, reaching 30%. The estimates of the potential losses (i.e. losses that would occur without the use of control methods) by animal pests and weeds averaged worldwide to 37 and 36%, respectively, whereas pathogens and viruses added about 9% to a total potential loss of almost 82% (Oerke, 2006). Despite the use of pest control measures, about 29% of the attainable production is lost to pests.

Pest management in cotton rely mainly on the use of pesticides, although many farmers, especially in developing countries, are not capable of applying pesticides effectively primarily due to limited knowledge of basic concepts of pest control (Ochou et al., 1998; Sinzogan et al., 2004; Midega et al., 2012; Khan and Damalas,

2015). Even in transgenic Bt cotton in developing countries, the majority of the farmers were found to rely heavily on chemicals to control key cotton pests (Yang et al., 2005; Arshad et al., 2009). Farmers' knowledge of pest management issues is one of the factors affecting pesticide use in practice. Previous studies showed that lack of knowledge on pest management and pesticide use among farmers was strongly correlated with excessive pesticide use (Chen et al., 2013; Khan et al., 2015). In the cotton belt of Punjab, Pakistan, there was a clear tendency towards pesticide overuse among farmers, but with a decreasing trend after training on integrated pest management (IPM), a high level of education, and use of highly toxic pesticides (Khan et al., 2015). Different from that in the developed countries, many farmers in developing countries do not receive extension services on the appropriate use of new pest control technologies (Midega et al., 2012).

Cotton production in Pakistan has been on the 'pesticide treadmill' in which heavy reliance on synthetic pesticides worked well for several years and in the end proved to be disastrous (Jabbar and Mallick, 1994; Iqbal et al., 1997; Khan et al., 2002; Tariq et al., 2007). Farmers all over the world utilize pesticides to protect commodities from pests and pathogens and maximize agricultural output both in terms of quantity as well as quality of the produce (Damalas, 2009; Damalas and Eleftherohorinos, 2011). However, ample use of pesticides in most sectors of the agricultural production in Pakistan has resulted in substantial health and environmental threats over the last decades (Iqbal et al., 1997; Khan et al., 2002; Tariq et al., 2007). Therefore, there is an urgent need to address pest management issues in the area, so that rural communities are well informed about pest control practices and be secured from health and environmental impact that put extra cost to the national economy. Farmers are looking for new management systems better adapted to their constraints. The selection of such systems that are expected to reduce pesticide costs, improve cotton yields, and ensure high profitability of cotton production, particularly for resource-poor farmers, is a challenge.

One of the major constraints upon establishing effective pest management approaches for smallholder farmers is the lack of adequate information about knowledge, perceptions and practices of farmers regarding pest management (Damalas et al., 2006a, b; Isin and Yildirim, 2007; Hashemi and Damalas, 2011; Hashemi et al., 2012). Notable failure of programs was observed in areas where farmers' knowledge was found to be inadequate. However, the need to understand farmer knowledge systems has been recognized as a basis for the development of pest management technologies that are adapted to local farmers' situations (Van Huis and Meerman, 1997; Norton et al., 1999; Damalas and Hashemi, 2010; Hashemi and Damalas, 2011) and meet their aspirations as a key condition to adoption of new practices (Settle et al., 2014). Therefore, the first step for the development of relevant pest management approaches is an evaluation of farmers' basic socio-economic characteristics, knowledge and perceptions of pests, current pest management practices as well as constraints to effective implementation of these pest management practices.

Identifying farmers' needs for knowledge and finding the appropriate way to provide it is a constant challenge. Farmers' surveys are always helpful because of their usefulness in setting the research agenda, testing research hypotheses, designing extension strategies, evaluating the effectiveness of projects and development interventions and so on. In this context, the aim of the present study was to identify potential points for intervention in the development of pest management strategies for cotton pests based on the needs of small-scale farmers in the area of Punjab, Pakistan. In particular, the objectives of the study could be divided to the following parts: a) to evaluate farmers' knowledge and perceptions of cotton pests, b) to examine farmers' current practices in

managing cotton pests, and c) to point out challenges and intervention opportunities in pest control that could lead to improved cotton productivity and increased personal safety of farmers in the area.

2. Materials and methods

2.1. Study area

The study was conducted in two districts of Punjab province in Pakistan, covering the key cotton-growing agro-ecologies in the region. Punjab is located at the north western edge of the geologic Indian plate in South Asia. This province contributes about 76% to annual food production in the country, with cotton and rice (*Oryza sativa* L.) being the cash crops that largely contribute to the national treasury. Almost 80% of cotton is produced in Punjab province under intensive use of pesticides. The districts Lodhran and Vehari were selected for the study. These two districts are historically well known for cotton production and have a long history of pesticide use (approximately 50 years). Both districts represent more than 17% of the area under cotton cultivation in Punjab and each district is subdivided administratively into three tehsils (i.e. counties).

2.2. Selection of sample

To obtain cross-sectional data for the study, the technique of multi stage cluster sampling was used. After selection of the districts, all three tehsils (counties) of each district were chosen for the survey as the representative area. At least three villages (clusters), from every tehsil were purposively selected in each district to get pesticide-related information from a sample of cotton farmers. According to the population of each tehsil, we enlisted 915 farmers from the two districts, with the help of local authorities, 412 from district Vehari and 503 from district Lodhran. Finally 400 farmers were randomly selected through an automatic random number generator. The selection of farmers was based on the willingness of each farmer to participate. The overall response rate was more than adequate, i.e. 80%, so that finally 318 interviews were successfully completed. Farmers who were not available at the time of the interview or those who provided incomplete information were not included in the study.

2.3. Data collection

Primary data gathering included group discussions with farmers and individual interviews. Secondary data gathering concerned collection of general information. Some participants in individual interviews did not participate in the group discussions and vice versa. Selected farmers were individually interviewed using open and semi-structured interviews to elicit their knowledge, perceptions, and practices in pest management. Although quite expensive, this method provides the highest response rates and is better suited to collecting complex information. The three tehsils from each district were selected as the representative area. To get information about pesticide use from pesticide applicators, at least three clusters/villages were identified from each tehsil. After locating the most well-informed person in each village, a farmers' list was prepared. The overall response rate (successful interviews completed) was 80%, including 85% response rate for Lodhran district and 75% response rate for Vehari district. Questions were related to farmers' ability to identify common and dangerous pests in cotton, perceptions of the impact on cotton yield, and common pest management practices in cotton. Farmers were also asked about common pesticide use practices in a growing season (i.e. other crops, pesticide products used, number of sprays per season,