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Farmers' perceptions and management of plant viruses in vegetables and legumes in tropical and subtropical Asia

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ABSTRACT

Incidence of vector-transmitted virus diseases and the damage caused to vegetable crops by these diseases are reported to be increasing in countries with tropical and subtropical conditions. Virus-resistant crops and an integrated approach to crop management including appropriate control of plant-virus insect-vectors could reduce the problem. However, in developing countries, such a strategy is rarely applied effectively. We surveyed 800 growers of chili, tomato and mungbean in India, Thailand and Vietnam to understand what farmers know about plant viruses, their perceptions about yield damage, the control methods they choose to apply and the perceived effectiveness of these. Farmers regarded their economic losses from pests and diseases to be very substantial. Only a minority of them knew that certain disease symptoms were probably being caused by a plant virus and even fewer knew about the role of insect vectors in its spread. Farmers mostly relied on synthetic pesticides to manage the virus disease symptoms they observed. If farmers had better knowledge about plant viruses, their insect vectors, and cost-effective, safer means of control, then use of synthetic pesticides could be reduced substantially. Building knowledge among farmers is therefore an important way to address the diseases caused by plant viruses, while the development of virus-resistant varieties and simple and effective methods of vector control offer longer-term solutions.

1. Introduction

Plant virus diseases cause tremendous economic losses, particularly in the tropics and subtropics (Varma and Malathi, 2003). Previous studies have suggested that virus diseases are spreading and intensifying (e.g. Ghini et al., 2011). However, virus diseases are difficult for farmers to identify. Symptoms such as leaf distortion, streaking and stunting, vein clearing, or mosaic can be similar in appearance to those caused by abiotic stresses or plant chimeras. Plant-infecting viruses vary greatly in their genetic makeup, mode of transmission and disease symptoms they induce. Many virus species show a high rate of mutation and there can be recombination or exchange of genetic components between related species, adding to the genetic diversity and variation in virulence and symptoms (García-Arenal et al., 2001). Also, two or more viruses can infect a plant at the same time; with synergistic or antagonistic effects between viruses (Méndez-Lozano et al., 2003; Syller, 2012), the identification of the disease or the causal agent from the symptoms alone may be impossible.

Knowledge about how viruses are transmitted and their infection cycle is important to control the spread of virus diseases, as no approved or reliable antiviral products are generally available. Small-scale farmers in developing countries often lack such knowledge and believe that pesticides can control the diseases. Left

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unmanaged or managed incorrectly, viruses can cause the loss of all harvestable yield. It is therefore important to understand what farmers know about plant viruses, their perceptions about crop yield damage, the control methods they choose to apply, and the perceived effectiveness of these methods.

Despite the value of this information, there have been very few studies addressing this topic, particularly in regard to smallholder farmers in developing countries. In a study in southern India, Nagaraju et al. (2002) surveyed 174 tomato farmers in five districts of Karnataka to understand their perceptions and management of tomato leaf curl virus disease caused by a complex of whitefly-transmitted begomoviruses. They found that farmers were generally aware of the symptoms of leaf curl, and of reduced leaf size and plant stunting caused by the viruses, but only 2% knew the disease was transmitted by whiteflies. Approximately 86% of the farmers believed the symptoms were, at least in part, caused by high temperatures. About 90% of the farmers relied on pesticides to control the disease. Colvin et al. (2012) followed up on this study and interviewed 75 tomato farmers in seven districts of Karnataka in 2003. They estimated that tomato leaf curl virus disease caused losses of up to one third of farmers' income during each season and showed through an experiment that tomato leaf curl virus disease-resistant tomato varieties gave nearly five times greater profit and reduced pesticide use compared with non-resistant varieties. In a broader study on tomato farmers' perception, knowledge and pesticide use in the Inle Lake region of Myanmar, Oo et al. (2012) observed that the farmers did not know which pests and diseases were affecting their crops, most had not heard about integrated pest management (IPM) and relied on pesticide applications to manage the diseases and pests and, on average, they made fewer applications of pesticides as they gained in experience and received training and extension information.

The studies cited above focused on tomato in South and Southeast Asia. However, many other diseases with likely virus etiology are present or are emerging in many of the other crops grown by smallholder farmers. Hot or chili peppers (*Capsicum* spp.) are important crops for many smallholder farmers across much of the tropics and subtropics, grown for home consumption and also as a source of cash income. As the area under pepper cultivation is increasing, particularly in southern and eastern Asia, so too is the incidence of pests and diseases. In India for example, high incidences of chili leaf curl disease caused by a whitefly-transmitted begomovirus (family *Geminiviridae*) is reported to have caused up to 100% crop losses in some areas, resulting in some farmers withdrawing from chili cultivation completely (Kumar et al., 2006; see also Sarath Babu et al., 2011). Mungbean (*Vigna radiata*) is also widely grown by smallholder farmers in southern and eastern Asia, though generally to provide valuable vegetable protein to the household diet rather than as a cash crop. Unfortunately, diseases caused by whitefly-transmitted begomoviruses have become a major constraint to mungbean production in many areas of India, Pakistan and Bangladesh (e.g. Akhtar et al., 2011) and are increasing in importance in other countries of the region such as Vietnam (Tsai et al., 2013).

This study was part of a larger project that aims to identify and develop components of integrated plant virus disease management packages, including deployment of natural host plant resistance, suitable for tomato, hot pepper and mungbean in India, Thailand and Vietnam. We wanted to find out what the growers of these crops know about pests and diseases, and how they perceive pests and diseases—particularly virus diseases—in their crops, and how this knowledge and perception influences how they manage their crops. This information could help guide plant virus disease management activities, as well as national extension systems, by identifying what types of actions might be required to promote more effective and sustainable management of plant virus diseases.

2. Materials and methods

2.1. Sample selection

This study focuses on tomato, chili and mungbean, as these crops are economically important in tropical and subtropical Asia but have been under particular pressure, or are under increasing pressure, from virus-related diseases. Data were collected from February 2013 to September 2013 in Thailand, Vietnam and Tamil Nadu, India. In Thailand, data were collected only for tomato and chili as mungbean is not widely cultivated. For each case, we identified the main production areas for open field cultivation by consulting local crop experts.

The research team then contacted the local administration or local extension office to select smaller administrative units such as districts or sub-districts where the crop is widely grown (Table 1). From these units a list was constructed of all villages with a substantial number of growers. We initially planned to randomly select 10 villages from this list and then to randomly select 10 growers from each village by constructing a list of all farmers growing the crop. This plan worked in Thailand, but in India and Vietnam there were not enough growers of the same crop in each village and we therefore selected more villages. The large number of villages selected for this survey ensured a minimal degree of spatial variation, which is necessary because the incidence of plant viruses can vary strongly between locations. Admittedly, it also varies over years, but we had to confine ourselves to a cross-sectional set of observations. With 100 growers interviewed per crop and per country, the total sample size for this study was 800 (3 data sets for chili and tomato and 2 data sets for mungbean).

2.2. Data collection and analysis

To compare the results across countries, we used a standard questionnaire that was translated into Thai, Vietnamese and Tamil. The respondent was the household member who usually made the decisions regarding the cultivation of the crop, such as input use, pest control, and selling of the produce. Questions could be asked to other household members if they were responsible for part of the decision-making (e.g. if the man did the pesticide spraying, but the woman sold the harvest). The interviews generally took between one and two hours to complete, depending on the scale of production and number of pesticides used. The questionnaire recorded input and output data for all tomato, chili or mungbean crops that were harvested in the previous 12 months. Thus there are variations in the recall period because planting and harvesting months varied between farmers. For Thailand and Tamil Nadu, India the recall period roughly referred to the 2012 calendar year, while for Vietnam the recall period was roughly from mid-2012 to mid-2013.

During the first part of each interview, basic background information on each respondent household, their land holding and farming enterprise was collected. The second part recorded the cropping calendar and details on the quantity and value of all inputs used for the tomato, chili or mungbean crop, as well as the harvested quantity, postharvest losses, home consumption and sales. Local quantity units were converted to kilograms or metric tons and area units were converted to hectares to make comparisons between the countries possible. Local currencies were converted to US dollars using official exchange rates averaged over the recall period of the survey.

The data were analyzed by calculating farm household averages per crop per country. If the standard deviations were high then we also calculated medians. We did not test for significant differences between the crops or between the countries because the objective of the study was not to test whether chili, tomato or mungbean production systems in these three countries are different.