SECTION FOUR

Whiteflies as Pests of Annual Crops in the Tropical Highlands of Latin America

BLANCA 268

CHAPTER 4.1

Introduction

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According to Strong et al. (1984), 724 species of whiteflies (Homoptera: Aleyrodidae) have been described from the tropics but only 420 from temperate regions. Most of these insects do not represent an economic threat to agriculture and only a handful can be described as serious pests. In a recent survey conducted in Central America and Colombia, Caballero (1992) listed the 30 commonest and economically most important whitefly species recorded from 84 host plant species. Among these, the sweetpotato whitefly *Bemisia tabaci* (Gennadius), the greenhouse whitefly *Trialeurodes vaporariorum* (Westwood) and the citrus whitefly *Aleurocanthus woglumi* Ashby were regarded as key pests. Of lesser importance were *Trialeurodes abutiloneus* (Haldeman) and three species affecting cassava: *Aleurotrachelus socialis* Bondar, *Bemisia tuberculata* Bondar and *Trialeurodes variabilis* (Quaintance).

T. vaporariorum and *B. tabaci* are by far the most important whitefly species affecting annual crops in the Latin American highlands and these two species are the focus of the present review. While reference is made to *B. tabaci* and *T. vaporariorum* as virus vectors, emphasis is on the importance of these insects as direct pests causing mechanical damage. The whiteflies affecting cassava (*Manihot esculenta* Crantz), a semi-perennial crop, are not discussed.

Legumes and Horticultural Crops in the Andean Highlands

The Andes encompass a wide range of latitudes and climates but in the tropics especially, altitude is the main determinant of temperature and biological character. Areas between 1000 and 2000 m above sea level are known as highlands. Those above 2000 m have a quasi-temperate climate and are collectively known as the "high Andes". Transitions from tropical lowlands to temperate highlands may be abrupt and the alpine zones form ecological islands, large or small. As indicated by Winograd et al. (1998), the Andean backbone and its lateral ranges contribute remarkable diversity to the ecosystems of Colombia and Ecuador. In parts of Colombia, small ridges and spurs connect the three main ranges, circumscribing a series of intermountain basins, each of which hosts a distinctive local community of natural biodiversity. Agricultural systems and their ecology are correspondingly diverse.

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The tropical highlands of Colombia and Ecuador include extensive agricultural areas with mean temperatures of 12-20 °C, variable rainfall patterns (700-1600 mm) and relative humidity ranging from 50% to 85%. Small-scale farmers grow common bean and snap bean (*Phaseolus vulgaris* L.), tomato (*Lycopersicon esculentum* Mill.), potato (*Solanum tuberosum* L.) and other horticultural crops, both for home consumption and for sale. Crops are usually grown on steep, erosion-prone slopes, with no irrigation and little or no use of fertilizers.

In contrast, the lowlands of Colombia and Ecuador experience mean temperatures of 26-28 °C, similarly variable rainfall patterns (600-1600 mm) and prolonged dry seasons that favour the buildup of whitefly populations. Cotton (*Gossypium hirsutum* L.), soybean (*Glycine max* [L.] Merr), melon (*Cucumis melo* L.) and, to a lesser extent, tomato are grown on large farms that occupy a significant proportion of the agricultural land. Many small-scale farmers also grow less than 1 hectare of legumes, vegetables or tobacco (*Nicotiana tabacum* L.).

Status of Research on *Trialeurodes* and *Bemisia*

The centre of origin for *T. vaporariorum* has not been identified. According to Vet et al. (1980), the species is most probably indigenous to tropical and subtropical America. *T. vaporariorum*, a well-known pest of greenhouse crops in Europe, has long been recorded on annual field crops in highland areas of Colombia (Posada, 1976) and Ecuador (Merino and Vásquez, 1962). It is confirmed as a competent vector of numerous plant viruses (Díaz et al., 1990; Duffus, 1987; 1996; Wisler et al., 1998; Salazar et al., 2000) but it is more important as a direct pest of several crops. This whitefly was viewed as a minor pest until the early 1980s (Cardona, 1995). Since then, *T. vaporariorum* has become a key pest on dry beans, snap bean, tomato, potato and ornamentals and is considered the most important whitefly species in the tropical highlands of South America. Damage is due to the continuous sucking of sap from the phloem by nymphs and adults and to the abundant excretion of honeydew that falls on leaves and fruits and serves as a substrate for fungi that block photosynthesis. Both the yield and quality of crops are affected. A series of trials in Colombia (Cardona et al., 1993; Prada et al., 1993) showed that high infestation levels (up to 450 nymphs/leaf) can reduce the yields of common bean by 38% and of snap bean by 54%.

Whitefly problems in snap bean production in Colombia have increased dramatically since the early 1980s and illustrate the need for integrated pest management (IPM) work on whiteflies. In an attempt to reduce pesticide use in whitefly-affected areas, a pilot project, funded by the International Development Research Centre (IDRC) of Canada, was initiated in the Sumapaz region of central Colombia. Surveys showed that all of 286 farmers interviewed were using insecticides as the sole method to manage whiteflies. Insecticide use averaged 11 applications in a 70-day cropping cycle. Most of the insecticides used were organophosphates and carbamates belonging to toxicological category I (highly toxic) as defined by Metcalf (1994): those insecticides with acute oral LD_{50} values of less than 50 mg/kg or dermal LD_{50} values of less than 200 mg/kg. Field tests indicated that seven of the 10 most widely used insecticides were ineffective for whitefly

control, due to resistance (Cardona, 1995). Research showed that simple sanitation measures such as leaf roguing and destruction of crop residues reduced overall whitefly infestation levels if implemented on a community-wide basis. In addition, selective use of granular insecticides delayed the need for the first foliar insecticide application, enhancing natural enemy activity. A relatively simple IPM package based on cultural control and sanitation practices, timely application of effective insecticides and reliance on natural biological control resulted in a 66% reduction in insecticide use (Cardona, 1995). Farmers' participation in the overall process was essential for widespread adoption of the system proposed. However, it was concluded that, before continuing with IPM training and scaling up, it was necessary to verify that patterns of *T. vaporariorum* distribution, reproductive hosts plants, perceptions of the problem and insecticide use were similar throughout the Andean region.

B. tabaci also has been documented as a pest of several crops in Colombia (Posada, 1976; Bolaño, 1997) and Ecuador (Merino and Vásquez, 1962). Except for sporadic outbreaks on cotton in Colombia (Alcaraz et al., 1990), this insect was generally regarded as a secondary pest until 1993 when serious outbreaks occurred in the western provinces of Manabí, Guayas, and Los Ríos in Ecuador. Mendoza et al. (1995) estimated that vegetable growers in the Guayas region lost US$400,000 per year as a result of whitefly attacks. Up to 10,000 ha of soybean were destroyed in the Guayas and Los Ríos provinces (Mendoza, 1996). Similar outbreaks occurred in 1996 in the north-western Departments of Sucre, Córdoba and Atlántico in Colombia (Quintero et al., 2001). The change in *B. tabaci*'s pest status was attributed to the introduction into the region of the B biotype (Quijije et al., 1995), which was first detected in Colombia in 1997 (Quintero et al., 1998).

A New Foundation for Whitefly IPM in the Andes

In view of the increasing importance of whiteflies in the Andean highlands, the launching in 1997 of a new project for "sustainable integrated management of whiteflies as pests and vectors of plant viruses in the tropics" by the Systemwide Programme on Integrated Pest Management was especially timely. A sub-project was established, under the co-ordination of the Centro Internacional de Agricultura Tropical (CIAT), to look specifically at "Whiteflies as pests in the tropical highlands of Latin America".

The purpose of the diagnostic phase of this sub-project (and of others addressing different whitefly problems around the world) was to provide a sound basis for future IPM efforts by gathering and analysing baseline data and so being able to characterize properly the nature of major whitefly problems. Specifically, in the Andean highlands, there was a need to describe the patterns of distribution of *T. vaporariorum* and *B. tabaci*, especially in relation to altitude, as well as the distribution of the newly introduced B biotype of *B. tabaci*. Information on the range of reproductive host plants and identification of natural enemies was also desired. Additional socio-economic information on crop losses, farmers' perception of the problems and patterns of insecticide use, as well as biological assessment of levels of insecticide resistance, were needed as a foundation for moving forward to more widespread adoption of IPM.

Surveys were conducted between October 1997 and December 1998 in whitefly-affected areas of Colombia and Ecuador while insecticide resistance testing continued through May 1999. The research was carried out in close collaboration among staff of CIAT and partner organizations, the Instituto Nacional Autónomo de Investigaciones Agropecuarias (INIAP) in Ecuador and the Corporación Colombiana de Investigación Agropecuaria (CORPOICA) in Colombia. The methods used and the results of the work are reported in the following two chapters.

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