O.38 - Evaluation of tools to manage whiteflies in European tomato crops – The Tomato Case Study

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Abstract

Whiteflies and whitefly-transmitted viruses present some of the most intractable constraints to European tomato production. The main objectives of the Tomato Case Study (TCS) were to: identify where and why whiteflies were a major limitation, collect information related to whiteflies and associated viruses; establish which management tools are available; identify key knowledge gaps and research priorities. Two whitefly species are pests of the tomato in Europe. *Bemisia tabaci* is widely distributed, *Trialeurodes vaporariorum* is ubiquitous. Biotypes B and Q of *B. tabaci* are widespread and problematic. Tomato crops are particularly susceptible to Tomato yellow leaf curl disease (TYLCD) and high incidences were associated to its vector, *B. tabaci*. Unlike other tomato pest species, the ranked importance of *B. tabaci* correlated with levels of insecticide use, showing *B. tabaci* to be one of the principal drivers behind chemical control. Confirmed cases of resistance have been reported to almost all insecticides. IPM based on biological control (IPM-BC) is applied in all the surveyed regions and was identified as the strategy consuming fewer insecticides. Other IPM components include greenhouse netting and TYLCD-tolerant tomato cultivars. Sampling techniques differ between regions, decisions are generally based upon whitefly densities and do not relate to control strategies or growing cycles. IPM-BC is the recommended strategy for a sustainable agriculture. However, some limitations for a wider implementation such as lack of biological solutions for some pests, costs of beneficials, low farmer confidence, costs of technical advice and low pest injury thresholds were identified. Research priorities to promote IPM-BC are proposed.

Tomato is one of the most widely grown vegetables in the world and in 2005, the European Union (EU), was the second largest producer (15% of fresh tomatoes harvested) after China (FAOSTAT, 2007). Fresh tomato production in EU amounted to around 17 million tonnes with a hectarage of 0.3 million ha mainly concentrated in the Mediterranean countries. In 2005 Europeans consumed 15 million tonnes of fresh tomato, 90% produced within the EU. The two leading suppliers were Spain and the Netherlands, together accounting for 60% of the total. In 2004 according to the Commission of the European Communities (2006), no pesticide residues were detected in 64% of tomato samples, 35% contained residues of pesticides at/or below the Maximum Residues Level (MRL) of pesticides authorised in the EU, and only 1% exceeded the MRL. Pesticide half-lives in soil were reported to be 16-fold slower than in the marketable product (Juraske et al., 2008), suggesting the use of pesticides has a greater impact on the environment than on food quality, and indicating pesticide reduction would contribute to more environmentally sustainable tomato production

European tomato crops are affected by a diversity of insect pests and diseases, among which, whiteflies and whitefly-transmitted viruses present some of the most intractable constraints. The main objectives of the Tomato Case Study (TCS) were: to identify areas where whiteflies were the major limitation to tomato production; to collect information on the status and biology of whiteflies and associated viruses; to establish which tools are available to manage whiteflies; to identify knowledge gaps that limit the uptake of integrated pest management (IPM) programs and research priorities that would promote their successful application. Studies in the framework of ENDURE-TCS were conducted from 2007 until June 2008.

Two questionnaires were prepared to achieve the TCS objectives. In the first questionnaire (TCS-Q1), 10 countries were surveyed and the topics covered were: whitefly species, *Bemisia tabaci* biotypes, insecticide resistance, whitefly-vectored virus species, whitefly natural enemies and their use in biological control, other control tools and sampling techniques for decision making. For the second questionnaire (TCS-Q2) the following four areas were selected due to their different levels of *B. tabaci* pressure and virus incidence: Germany, southern France, northern Spain, and southern Spain. TCS-Q2 data were grouped according to growing cycles that related to transplanting dates and growing conditions. Four different pest control strategies were defined: Chemical (based only on the use of insecticides), IPM-Insecticide (IPM based on the rational use of insecticides), IPM-BC (IPM based on biological control) and Organic production (insecticide-free approaches). Following are the results and conclusions arising from the questionnaires, the author's personal experience and from literature.

Tomato crops were found to be affected by a diversity of insect pests and diseases, some being widely distributed and others restricted to specific areas or crop cycles. Two major whitefly species affect European tomato production, *B. tabaci* and *T. vaporariorum. Bemisia tabaci* in particular, is capable of causing severe losses even at low densities due to the range of plant viruses it can transmit. These include some of the most damaging viruses affecting tomatoes, such as *Tomato yellow leaf curl virus* (TYLCV). Other key pests were: the eriophyoid mite *Aculops lycopersici* and the insects *Helicoverpa armigera, Frankliniella occidentalis* and leafminers.

Bemisia tabaci is widely distributed, although outdoors its northerly limit extends across southern France, southern Italy, around the northern coast of the Mediterranean Sea and across northern Turkey. In most of the tomato growing areas mixed infestations of both whitefly species are common. Single populations of *T. vaporariorum* are usually found in northern Europe. Single infestations of *B. tabaci* are reported from Israel, and some areas of Spain, Greece, Morocco and Turkey. At least four biotypes of *B. tabaci* are currently present in Europe. Due to their invasive and damaging nature, the two most widespread and problematical within agricultural environments are biotypes B and Q. Although they are known to coexist in some areas, biotypes B and Q do not interbreed.

Tomato crops are particularly susceptible to more than 50 different species of the Begomovirus genus, and among them to a group of species, responsible for *Tomato yellow leaf curl disease* (TYLCD). This group causes the most devastating virus disease complex of tomato in warm temperate regions of the world. Comparison of data from the TCS-Q2 concerning virus importance and insect vector prevalence revealed that wherever the pressure of *B. tabaci* is high, viruses responsible for TYLCD were classed as important or very important. A less significant group of whitefly transmitted viruses is the Crinivirus genus, to which belong *Tomato chlorosis virus* (ToCV) and *Tomato infectious chlorosis virus* (TICV) species. ToCV is transmitted by *B. tabaci* and *T. vaporariorum* and TICV is transmitted by *T. vaporariorum*. In the case of ToCV and TICV no strict correlation between virus importance and insect vector prevalence was observed. Difficulties with identification of the symptoms caused by ToCV and TICV, as opposed to those of nutritional deficiency or ageing of the plants, can result in delays between the outbreak of criniviruses in a new area and their subsequent detection.

Sampling techniques for decision making are generally based upon whitefly densities and were not related to control strategies or growing cycles. Whitefly populations (adults and/or old nymphs) are usually sampled weekly or fortnightly and each country or area is using its own procedure for population follow-up and decision making. For population monitoring and control, whitefly species are always identified. Decisions are made on either a calendar or threshold basis, although calendar decisions are generally restricted to chemical strategies. Data from TCS-Q2 revealed that within protected environments, IPM-insecticide was used in 70% of the surveyed area, IPM-BC in 25%, chemical control in 5% and organic production was the least common of all strategies. As expected, the number of insecticide applications per month for whitefly control is higher in IPM-Insecticide than in IPM-BC strategies in all areas except Germany (low whitefly pressure) and northern Spain. IPM-Insecticide uses 18% less active ingredients (a.i.) per application than the chemical strategy and 17% more a.i. per application than IPM-BC.

Unlike other pest species of tomatoes, the ranked importance of *B. tabaci* within each of the four surveyed regions closely correlated with levels of insecticide use. This showed *B. tabaci* to be one of the principal insect pests driving insecticide use, primarily due to the threat of TYLCD and the resulting low tolerance thresholds that it imposes. The range of insecticides targeted against whiteflies across the four regions surveyed in TCS-Q2 spans organophosphate, pyrethroid, carbamate and neonicotinoid chemistries, in addition to specific insect growth regulators, pymetrozine and pyridaben.

Confirmed cases of resistance have been reported for both *T. vaporariorum* and *B. tabaci* to many compounds.

According to TCS-Q1, natural enemies used for biological control of whiteflies in vegetables are primarily *Eretmocerus mundus*, *Typhlodromips (= Amblyseius) swirskii* and *Macrolophus caliginosus*, and to a lesser extend *Nesidiocoris tenuis* and the exotics *Eretmocerus eremicus, Encarsia formosa* and *Dicyphus hesperus*. IPM-BC is applied in all 4 tomato growing areas surveyed in TCS-Q2, the largest hectarage (> 2000ha) being in southern Spain. Biological control of whiteflies in tomato production is mainly based on inoculative releases of the parasitoids *E. mundus* and *E. formosa* and/or the polyphagous predators *M. caliginosus* and *N. tenuis*. Biological control is used mainly within the framework of IPM to control a range of pests. In those programmes, selective pesticides are applied for pests lacking biological solutions or when biological control fails to maintain the target pest under economic thresholds. Natural enemies are also used in organic production although the hectarage of tomatoes under this production system is limited.

Important components of IPM strategies are the use of nets in vents and double-door entry systems to reduce the movement of *B. tabaci* into greenhouses, and the use of tomato varieties tolerant to TYLCD in areas of high TYLCD incidence. Most tolerant commercial cultivars have the *Ty*-1 gene and show a reduced susceptibility to the virus rather than resistance. Moreover, these tolerant cultivars need additional protection from viruliferous insects during the first months after planting. Another approach would be to focus on plant-based resistance to the vector, but at present there are no tomato varieties fully resistant to whiteflies.

From results obtained within the TCS, IPM-BC is the recommended control strategy for sustainable agriculture. However, limitations for uptake of IPM programmes were identified. The most extensive were ‘lack of a biological solution for some pests’ and ‘cost of the natural enemies’. ‘Low acceptance of the method on behalf of the farmer’ was also reported, especially around the Mediterranean basin. Other limitations listed were ‘costs associated with technical advice’ and low ‘pest injury thresholds’ mainly in those areas with high incidence of TYLCD. To overcome these limitations research on the following domains was proposed: (i) emergence and invasion of new whitefly-transmitted viruses; (ii) the relevance of *B. tabaci* biotypes regarding insecticide resistance; (iii) biochemistry and genetics of plant resistance; (iv) economic thresholds and sampling techniques of whiteflies for decision making, and (v) knowledge on the native natural enemies of whiteflies and on other natural biological agents for tomato pest control.

Key information from TCS has been collated in a leaflet and disseminated amongst pest advisors and plant protection services to transfer the available techniques and the knowledge on IPM for a wider, efficient and successful implementation.

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