Summary

Whiteflies and whitefly-transmitted viruses are major constraints in European tomato production. ENDURE's Tomato Case Study set out to identify where and why whiteflies are a major limitation, collect information related to whiteflies and associated viruses, establish which management tools are available and identify key knowledge gaps and research priorities. Data from research conducted by case study members, a review of current literature and two questionnaires conducted across several European tomato growing areas allowed members to achieve these objectives.

Two whitefly species are pests of tomato in Europe. *Bemisia tabaci* is widely distributed, while *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 are associated to high *B. tabaci* pressure. Unlike other tomato pests, the importance of *B. tabaci* correlates with levels of insecticide use, showing it to be a principal driver in chemical control. Confirmed cases of resistance have been reported to almost all insecticides.

IPM based on biological control (IPM-BC) is used in all the surveyed regions and identified as the strategy using 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 sustainable tomato production in Europe. However, some limitations for wider implementation such as lack of biological solutions for some pests, costs of beneficials, low farmer confidence, cost of technical advice and low pest injury thresholds were identified. Research priorities to promote IPM-BC are proposed.

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About ENDURE

ENDURE is the European Network for the Durable Exploitation of Crop Protection Strategies. ENDURE is a Network of Excellence (NoE) with two key objectives: restructuring European research and development on the use of plant protection products, and establishing ENDURE as a world leader in the development and implementation of sustainable pest control strategies through:

> Building a lasting crop protection research community
> Providing end-users with a broader range of short-term solutions
> Developing a holistic approach to sustainable pest management
> Taking stock of and informing plant protection policy changes.

Eighteen organisations in 10 European countries are committed to ENDURE for four years (2007-2010), with financial support from the European Commission's Sixth Framework Programme, priority 5: Food Quality and Security.

Website and ENDURE Information Centre

www.endure-network.eu

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Tomato Case Study – Guide Number 1

Evaluation of Tools to Manage Whiteflies in Europe

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Tomato production and detail of tomato fruits. © IRTA Entomology, Spain

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diversifying crop protection

Food Quality and Safety
SIXTH FRAMEWORK PROGRAMME

Evaluation of Tools to Manage Whiteflies in Europe

Controlling whiteflies and the viruses they transmit are a major challenge for European tomato producers

Tomatoes are the most widely grown vegetable in the world and in 2005 the European Union (EU) was the second largest producer (after China) with annual production of 17 million tonnes (FAOSTAT, 2007). In 2005, Europeans consumed 15 million tonnes of fresh tomatoes, 90% produced within the EU.

Data generated by the 2004 EU pesticide residues monitoring report showed that 1% of tomato samples exceeded the MRL (maximum residue limits). Pesticide biodegradation in soil is reported to be much slower than in the plant. Thus, when considering the whole food chain, the use of pesticides has a greater impact on the environment (farm) than on food (fork).

ENDURE's Tomato Case Study has examined European tomato production and the tools available for management of key pests with a special focus on *Bemisia tabaci* and the incidence of whitefly-transmitted viruses.

***Bemisia tabaci* (whitefly) and symptoms of tomato yellow leaf curl disease (TYLCD).**

Key pests

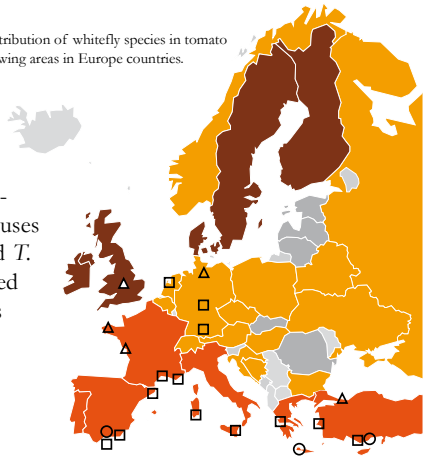
The relative economic importance of individual pest species in different areas of Europe varies according to local cultivation practices, the environment and cropping cycles. Two whitefly species are key pests: *Bemisia tabaci,* widely distributed around the Mediterranean basin, and *Trialeurodes vaporariorum,* ubiquitous but predominant in northern locations (see map). At least four biotypes of *B. tabaci* are currently present in Europe. The two most widespread and problematical for agriculture are biotypes B and Q, which are known to coexist in some areas but do not seem to interbreed.

Other insect pests ranked as important in at least some areas are: *Helicoverpa armigera* (during summer), leaf miners (mainly in long growing cycles) and *Frankliniella occidentalis*. The russet mite *Aculops lycopersici* is an increasingly harmful pest around the Mediterranean.

Whitefly-vectored viruses

Bemisia tabaci causes severe losses due to the transmission of tomato yellow leaf curl disease (TYLCD) and there is a high incidence of the viruses responsible for TYLCD when *B. tabaci* pressure is high. A less significant group of whitefly-transmitted viruses is the tomato chlorosis virus (ToCV), transmitted by *B. tabaci,* and *T. vaporariorum,* and tomato infectious chlorosis virus (TICV) transmitted by *T. vaporariorum*. In these cases, no strict correlation between virus importance and insect vector prevalence is observed.

Distribution of whitefly species in tomato growing areas in Europe countries.



In colours: = outdoor and protected crops, = primarily protected crops, = absent or non-persistent, = absent or non persistent (protected zone), = no information.

In symbols: ○ = *B. tabaci*, △ = *T. vaporariorum* and □ = mixed populations of *B. tabaci* and *T. vaporariorum*. (Data from ENDURE questionnaires).

Whitefly control strategies

Of the integrated pest management (IPM) strategies identified, IPM based on insecticide application (IPM-Insecticide) was used in 70% of the surveyed area, IPM based on biological control (IPM-BC) in 25% and chemical control only in 5%. The number of insecticide applications per month is higher in IPM-Insecticide than in IPM-BC.

Not only insecticide applications but active ingredients (a.i.) are also saved using IPM strategies: IPM-Insecticide uses 18% less a.i./application than the chemical strategy and 17% more a.i./application than IPM-BC. *Bemisia tabaci* is one of the principal insect pests driving insecticide use, primarily due to the threat of TYLCD and the resulting low tolerance thresholds it imposes.

Insecticide resistance has been reported for both whiteflies, especially for *B. tabaci,* to all the pesticide compounds used: organophosphate, pyrethroid, carbamate and neonicotinoid, and the specific insect growth regulators pymetrozine and pyridaben. Therefore, IPM-BC is the recommended control strategy for more sustainable tomato production.

Sampling techniques for population follow-up and decision making do not depend on control strategies and differ between regions. Decisions are generally based upon whitefly densities and whitefly species are always identified.

Other control tools

An additional component of IPM strategies is the use of nets in vents and double-door systems to reduce the entry of *B. tabaci* into greenhouses, however compensations have to be made for the reduced ventilation this entails. The use of tomato varieties tolerant to TYLCD is useful in reducing economic impacts, but these varieties need additional protection from virus-transmitting insects during the first month after planting because they show reduced susceptibility to the virus rather than resistance. At present, there are no tomato varieties resistant to whiteflies. However, strong resistance is present in wild relatives and this might be introduced by breeding.

Biological controls

IPM-BC of whiteflies in tomatoes is mainly based on inoculative releases of the polyphagous predators *Macrolophus caliginosus* and *Nesidiocoris tenuis*, and the parasitoids *Eretmocerus mundus* and *Encarsia formosa*. *Eretmocerus mundus* is used in areas with high *B. tabaci* populations and *Encarsia formosa* is used, principally, for *T. vaporariorum* control. Rates of natural enemies are very variable depending on the area and crop cycle. In northern Spain, a programme based on the conservation of native populations of *Macrolophus* is also used. The fact that *N. tenuis* can cause damage to tomato plants when prey is scarce probably results in lower recommended release rates.

Factors limiting IPM uptake

Factors limiting IPM uptake include lack of biological solutions for some pests, costs of beneficials, low farmer confidence, increase costs of technical advice and low pest injury thresholds. To overcome these, research needs to be conducted on the emergence and invasion of new whitefly-transmitted viruses, on the relevance of *B. tabaci* biotypes regarding insecticide resistance, on the biochemistry and genetics of plant resistance towards whitefly, on economic thresholds and whitefly sampling techniques for decision making and on native whitefly natural enemies and other natural biological agents for tomato pest control. Efficient training of farmers and advisors will help to improve knowledge on IPM-BC strategies and boost end-user confidence in this method.

Natural enemies (from top to bottom): *Macrolophus caliginosus*, *Nesidiocoris tenuis*, *Encarsia formosa* and *Eretmocerus mundus*.

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