IPM factsheet 1: Alternatives to carbosulfan for controlling whitefly in tomato

Problems caused by whiteflies

Whiteflies of several species may attack tomato and related crops. At low population levels of these sap-sucking pests, crops generally suffer little damage but at high levels, plants can wilt, the foliage becomes dry and brown and badly infested plants may die. When feeding, whiteflies excrete honeydew, a sticky fluid which can cover leaves and flowers. Dark coloured mould fungi may grow on the honeydew deposits, sometimes covering large areas of the leaf surfaces and reducing the plant's ability to photosynthesise and the quality of the crop. The most serious problem related to whitefly attack is the transmission of plant disease viruses, especially Tomato Yellow Leaf Curl Virus (TYLCV). The whitefly *Bemisia tabaci* is the insect vector for this disease, which can spread fast in an infected field and stunt plant growth, damage the leaves and flowers and drastically reduce fruit yield.

The importance of taking an IPM approach

Too often, tomato growers rely on synthetic insecticides as their main control method for sucking pests such as whitefly. However, **c**hemical control of whiteflies is expensive and increasingly difficult. Apart from the cost of insecticides, growers also need to consider the disadvantages of chemical use for this particular pest:

Risk of developing resistance: whiteflies are renowned for rapidly evolving resistance to commonly used insecticides. In many countries and crops, severe whitefly outbreaks are triggered by excessive or inappropriate use of insecticides.

Risk of secondary pest outbreaks: this can happen when spraying of broad-spectrum insecticides, such as carbosulfan, kills off the natural enemies of whitefly, which normally keep this pest from reaching problem levels.

Difficulties in targeting whiteflies: Whiteflies usually live on leaf undersides, where they are protected from overhead spraying. Contact insecticides needs to thoroughly cover the foliage, above and below, to achieve the desired control. Poor application can miss the majority of whiteflies and make it more likely that the pest will start to develop resistance.

The key to effective Integrated Pest Management of whitefly is advance planning to put preventative measures into place from before the tomato growing season starts. Waiting until the crop is already suffering whitefly-related problems is too late.

Preventative measures that tomato growers can take

Careful site selection and timing of tomato cultivation: Avoid growing tomato at periods when whitefly infestation is most likely or growing whitefly susceptible crops continuously as populations can expand rapidly when they have a continuous food source. Avoid planting

next to neighbouring infested crops or crops that are susceptible to whitefly attack (e.g. eggplants, beans, squash). District-level organisation of a closed period between growing seasons, when no whitefly-susceptible crops can be grown, helps break the whitefly life cycle and reduces future population levels.

Grow tomato varieties resistant to or tolerant of leaf curl or other virus diseases

Use physical protection for seedlings during nursery production: Young tomato plants are the most vulnerable to serious damage from whitefly attack and this is also the susceptible stage for virus infection. Using fine mesh to cover seedlings and exclude adult whiteflies from egg-laying is the best way to raise healthy, virus-free seedlings.

In Central America: IPM tomato smallholders now grow their seedlings in 'microtunnels', made of plastic or metal hoops covered with fine nylon mesh, for the first 3-4 weeks.

Good field hygiene: Whiteflies can be attracted to many weeds so take care to transplant into well-cleaned fields. After transplanting, pull up any plants that are badly infested by whiteflies or showing symptoms of virus disease and destroy these by burning or burying. Removing the older, bottom leaves as the plants mature is also helpful. After harvest, remove all tomato crop waste from the field and destroy any infested material. Pull up any volunteer tomato plants which survive or emerge. These hygiene practices are essential to prevent carry-over of infested material into the next season.

Grow a healthy crop: at nursery and transplanting stages, ensure proper spacing and avoid high doses of nitrogen fertiliser, which can make the plants more attractive to sucking pests.

Plant border crops as barriers: Fast-growing crops, e.g sorghum, pearl millet or maize, planted 3 rows wide around the tomato field act as physical barriers to invading whitefly.

Protective mulches: Whiteflies are repelled by silvery or white coloured ground coverings, which reflect UV light and make it difficult for them to locate the host plants. Placing reflective polyethylene mulches on planting beds before transplanting can reduce whitefly colonization and delay the build-up of damaging numbers for long enough to protect young plants from viral infection. As mulches lose their effectiveness when more than 60% of the surface is covered by foliage they work only for the first few weeks after transplanting. A cheaper, more accessible option for smallholders than plastic is to use straw or sawdust.

In East Africa: IPM smallholders spread straw mulch thickly around the base of tomato plants along the crop row, which deters whiteflies, conserves moisture and suppresses weeds.

Use of living cover or companion crops: Intercropping tomato with crops such as sorghum helps to reduce whitefly numbers. Some crops can be planted as ground cover to protect young plants from attack, deterring whitefly in a similar way to reflective mulches.

In Costa Rica: Coriander works as a good cover crop as it is quick growing. If sown directly into the field, at the same time as the tomato is sown in the nursery, by the time the seedlings are ready to transplant , the coriander will be growing well and its dense canopy will 'camouflage' the young transplants. The coriander is harvested within 35 days of transplanting, so that it does not compete with the crop. The cover crop presence is enough

to avoid tomato yield loss, even if there is some attack and virus infection later. Farmers gain additional income from the sale of fresh coriander.

Encouraging natural biological control: Whiteflies are attacked by many different natural enemies. These include: ***parasitic wasps***, especially *Encarsia* and *Eretmocerus* species, whose larvae feed on the immature whitefly stages and can be effective at finding and controlling low whitefly densities; ***predatory insects***, notably green lacewing *Chrysopa* species and various ladybird beetle species, which prey on this pest and are effective at high whitefly densities; and ***fungal diseases***, including *Beauveria*, *Paecilomyces* and *Verticillium* species. In conditions of high humidity, fungal diseases can infect whitefly colonies in crop foliage and prevent their reproduction and spread. Avoiding use of insecticides, especially in the early season, is the best way to conserve insect natural enemies. They can be further encouraged by providing suitable vegetation as habitat in and around fields and additional food sources, such as flowering plants. Mass-reared natural enemies of whitefly are available as commercial biocontrol agents in many countries for releasing into greenhouses.

Direct interventions when extra control is needed

Regular field monitoring to observe the health of the crop is a basic principle of IPM. This aspect is very important for whitefly management and enables growers to spot initial early whitefly 'hot spots' and consider when and where they need to take control actions.

In China: IPM monitoring is recommended weekly from transplanting, observing a sample of plants, especially leaf under sides. Growers should take action when whitefly levels exceed 10-20 plants with leaf damage symptoms or >50 whiteflies on 10-20 plants per hectare.

Using yellow sticky traps: Squares of yellow plastic or board painted yellow and covered with glue work to attract whiteflies, which then get caught on the sticky surface. They are often used as a monitoring tool to observe when and where whiteflies begin to invade a crop.

In India: yellow sticky traps placed at 12 traps per hectare are used to monitor whitefly levels and decide on the timing of any control actions needed.

Sticky traps can also be used as a method for mass trapping whitefly, placed at more frequent spacing in the crop than for monitoring. Lengths 2m x 75cm of oil-coated plastic suspended on sticks can also be moved across the field by two people, 2 rows at a time, who gently knock the plants to disturb the flying adults, which then get stuck.

In East Africa: ready-prepared lengths of sticky trap can be purchased to hang above the crop in greenhouse production of tomato. Farmers can also make their own from yellow plastic sold by the metre and coating 40cm strips of this with glue or light oil, then fixing to stakes approx. 1 metre high to suspend along the tomato rows but not touching the foliage.

Biopesticides: commercial biopesticides of selected strains of *Trichoderma*, *Paecilomyces, Beauveria a*nd *Verticillium lecanii* fungi are available as fungal biocontrol agents for whitefly in some countries. They can be applied in nursery and as a foliar spray in the field. Research in Costa Rica with novel products using native strains of *Paecilomyces a*nd *Verticillium* fungi found that these biopesticides gave a better performance in terms of yield and net profit than using insecticides, when applied at a similar frequency of 10-12 applications per season.

Soap sprays and botanical extracts : Using solutions of household detergent, soap bars or commercial pest control products based on soap or fatty acids can work well as a foliar spray to control larval whiteflies and other non-winged sucking pests. They work by blocking the insect's spiracles (breathing holes) and suffocating it. Natural enemies are generally not affected.

Numerous botanical extracts are in use for bollworm and other pests. They often work more by repelling or confusing the pest with the taste or odour or discouraging it from feeding than by direct toxicity. Extracts from the seed of the neem tree, either commercial products or home-made preparations are the most commonly used.

Recipes and application instructions for soap solutions and botanical extracts can be found in PAN Germany's OISAT database for non-chemical pest management in the tropics.

Sources of information used

Tomato Integrated Pest Management. An Ecological Guide. FAO Inter-country programme for vegetables in South and South-east Asia (2000). Via: http://www.share4dev.info/ffsnet/output_view.asp?outputID=3516

Controlling whitefly in tomato. World Vegetable Centre video, in Kiswahili with English subtitles, 8 mins. Via: http://avrdc.org/portfolio-items/controlling-whitefly-tomato/

OISAT field guide: Non-chemical methods for tomato production. PAN Germany, 2005. Via: http://www.oisat.org/downloads/field_guide_tomato.pdf

Tomato pest management section and and TYLCV management.Infonet Biovision. Via: http://www.infonet-biovision.org/PlantHealth/Crops/Tomato

CABI Plantwise documents: Factsheet for Farmers on Tomato Yellow Leaf Curl Virus (India, 2016); Factsheet for Farmers on Tomato Whitefly (Cambodia, 2013) and Pest Management Decision Guide green and yellow list for whitefly in tomato (China). Via: www.plantwise.org and search under 'Knowledge Bank'.

Mycoinsecticide development for integrated management of whitefly Bemisia tabaci in fruit and vegetable crops in neotropical zones. Technical report presentation [in Spanish], CATIE Costa Rica and Corpoica Colombia joint project, 2002-2006. *Via:* http://s1.fontagro.org/proyectos/desarrollo-de-micoinsecticidas-para-el-manejo-integrado-de-la-mosca-blanca-bemisia-tabaci-

Living cover crops for whitefly management [in Spanish]. Hilje, L (2002). Leaflet Collection Ecological Agriculture for Farmers. CATIE, Costa Rica. Via: http://repositorio.bibliotecaorton.catie.ac.cr:8080/bitstream/handle/11554/796/Coberturas_vivas_para_el_manejo.pdf?sequence=1&isAllowed=y

Management of *Bemisia tabaci* in Central America & the Caribbean: a decade's experience. [in Spanish] Hilje, L. (2002) *Manejo Integrado de Plagas y Agroecologia* (Costa Rica) 65 102-108 *Via:* http://www.sidalc.net/repdoc/A2034E/A2034E.PDF

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