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Data Sheets on Quarantine Pests

Bemisia tabaci

IDENTITY

Name: *Bemisia tabaci* (Gennadius)
Synonyms: *Bemisia gossypiperda* Misra & Lamba
Bemisia longispina Priesner & Hosny
Bemisia nigeriensis Corbett
Taxonomic position: Insecta: Hemiptera: Homoptera: Aleyrodidae
Common names: Tobacco whitefly, sweet potato whitefly, cotton whitefly (English)
Aleurode du cotonnier, aleurode de la patate douce (French)
Mosquita blanca del tabaco (Spanish)
Notes on taxonomy and nomenclature: The genus *Bemisia* contains 37 species and is thought to have originated from Asia (Mound & Halsey, 1978). *B. tabaci*, being possibly of Indian origin (Fishpool & Burban, 1994), was described under numerous names before its morphological variability was recognized. For full synonymy see Mound & Halsey (1978). Three distinct groups of *B. tabaci* have now been identified by comparing their mitochondrial 16S ribosomal subunits. These are: (a) New World, (b) India/Sudan, (c) remaining Old World (Frohlich & Brown, 1994).

First reports of a newly evolved biotype of *B. tabaci*, the B biotype, appeared in the mid-1980s (Brown *et al.*, 1995b). Commonly referred to as the silverleaf whitefly or poinsettia strain, the B biotype has been shown to be highly polyphagous and almost twice as fecund as previously recorded strains and has been documented as being a separate species, *B. argentifolii* (Bellows *et al.*, 1994). The B biotype is able to cause phytotoxic disorders in certain plant species, e.g. silverleaf in squashes (*Cucurbita* sp.) and this is an irrefutable method of identification (Bedford *et al.*, 1992, 1994a). A distinctive non-specific esterase banding pattern is also helpful in identification (Brown *et al.*, 1995a), but not infallible (Byrne *et al.*, 1995).

The authors' described morphological characters are, however, highly debatable and are presently under investigation (Rosell *et al.*, in preparation). As one example of the problems involved, one may note that the presence or absence of spines on the 'puparium' is now known to be determined by the smoothness or hairiness of the leaves of the host plant (Bedford *et al.*, 1994a), yet the absence of a small anterior submarginal seta on the 4th larval instar/puparium stage has been described as one of the identifying morphological features of so-called *B. argentifolii*. No Old World populations of *B. tabaci* studied so far can be distinguished from so-called *B. argentifolii* by this or other morphological features, although these Old World populations do not induce phytotoxic disorders or exhibit B biotype esterase banding patterns. It may be noted, finally, that several other biotypes (up to K) have been described (Brown *et al.*, 1995b), which supports the idea of a species complex, rather than of a number of distinct species such as *B. argentifolii*.
Bayer computer code: BEMITA
EPPO A2 list: No. 178
EU Annex designation: I/A1 (non-European populations); I/B (European populations)

HOSTS

Until recently, *B. tabaci* was mainly known as a pest of field crops in tropical and sub-tropical countries: cassava (*Manihot esculenta*), cotton (*Gossypium*), sweet potatoes (*Ipomoea batatas*), tobacco (*Nicotiana*) and tomatoes (*Lycopersicon esculentum*). Its host plant range within any particular region was small, yet *B. tabaci* had a composite range of around 300 plant species within 63 families (Mound & Halsey, 1978). With the evolution of the highly polyphagous B biotype, *B. tabaci* has now become a pest of glasshouse crops in many parts of the world, especially *Capsicum*, courgettes (*Cucurbita pepo*), cucumbers (*Cucumis sativus*), *Hibiscus*, *Gerbera*, *Gloxinia*, lettuces (*Lactuca sativa*), poinsettia *(Euphorbia pulcherrima*) and tomatoes (*Lycopersicon esculentum*). *B. tabaci* moves readily from one host species to another and is estimated as having a host range of around 600 species (Asteraceae, Brassicaceae, Convolvulaceae, Cucurbitaceae, Euphorbiaceae, Fabaceae, Malvaceae, Solanaceae, etc.).

GEOGRAPHICAL DISTRIBUTION

EPPO region: Present and widespread in the field in Algeria, Cyprus, France (South), Greece, Israel, Italy (including Sardinia and Sicily), Libya, Malta, Morocco, Portugal (locally distributed on the mainland), Slovakia, Spain (including Canary Islands), Turkey and Ukraine; of limited distribution and confined almost totally to glasshouse crops in Austria, Belgium, Czech Republic, Denmark, France (Central and North), Germany, Hungary, Malta, Netherlands, Norway, Poland, Russia, Sweden, Switzerland, Tunisia and Ukraine. In Denmark, Germany, Netherlands, eradication programmes are in operation. Outbreaks have also occurred in Finland, Ireland and UK but have been successfully eradicated. The presence of the B biotype has been confirmed in Cyprus, France (South) (Villevieille & Lecoq, 1992), Israel, Italy, Spain and in the glasshouse infestations of northern Europe (e.g. Netherlands), but the situation of the B biotype in the EPPO region is still not entirely clear.
Asia: Afghanistan, Azerbaijan, Bhutan, China (Fujian, Guangdong, Hainan, Sichuan, Shaanxi, Yunnan, Zhejiang), Cyprus, Georgia, Hong Kong, Israel, India (Andhra Pradesh, Assam, Bihar, Delhi, Gujarat, Haryana, Jammu and Kashmir, Kerala, Karnataka, Maharashtra, Meghalaya, Madhya Pradesh, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal), Indonesia (Java, Sulawesi, Sumatra), Iran, Iraq, Japan (Honshu, Shikoku), Jordan, Kuwait, Lebanon, Malaysia (Peninsular, Sarawak), Myanmar, Nepal, Oman, Pakistan, Philippines, Saudi Arabia, Sri Lanka, Syria, Taiwan, Thailand, Turkey, Turkmenistan, United Arab Emirates, Uzbekistan, Viet Nam, Yemen. The B biotype has been recorded in Cyprus, India, Israel, Japan and Yemen.
Africa: Algeria, Angola, Burkina Faso, Cameroon, Cape Verde, Central African Republic, Chad, Côte d'Ivoire, Egypt, Equatorial Guinea, Ethiopia, Gambia, Ghana, Guinea, Kenya, Libya, Madagascar, Malawi, Mauritius, Morocco, Mozambique, Nigeria, Réunion, Rwanda, Senegal, Sierra Leone, Somalia, South Africa, Sudan, Togo, Tunisia, Tanzania, Uganda, Zaire, Zimbabwe. The B biotype is present in Egypt and South Africa.
North America: Bermuda, Canada (under glass: Alberta, British Columbia, New Brunswick, Nova Scotia, Ontario, Quebec), Mexico, USA (outdoors in southern states, otherwise under glass: Arizona, California, Florida, Georgia, Hawaii, Maryland, New York, Pennsylvania, Texas). The B biotype is confirmed in Mexico and USA (southern states, Hawaii, New York).
Central America and Caribbean: Antigua and Barbuda, Barbados, Belize, Costa Rica, Cuba, Dominica, Dominican Republic, El Salvador, Guadeloupe, Guatemala, Haiti, Honduras, Jamaica, Martinique, Nicaragua, Panama, Puerto Rico, Trinidad and Tobago. The B biotype has been recorded in Central America and the Caribbean Basin.

South America: Argentina, Brazil (Bahia, Parana, Rio Grande do Sul, São Paulo), Colombia, Paraguay, Venezuela. The B biotype is present in Brazil.
Oceania: Australia (New South Wales, Queensland, Victoria, Western Australia), Fiji, Micronesia, Northern Mariana Islands, New Zealand, Papua New Guinea, Samoa, Solomon Islands, Tuvalu. The B biotype is present in Australia.
EU: Present.
Distribution map: See CIE (1986, No. 284) and IAPSC (1985, No. 188).

BIOLOGY

Eggs are laid usually in circular groups, on the underside of leaves, with the broad end touching the surface and the long axis perpendicular to the leaf. They are anchored by a pedicel which is inserted into a fine slit made by the female in the tissues, and not into stomata, as in the case of many other aleyrodids. Eggs are whitish when first laid but gradually turn brown. Hatching occurs after 5-9 days at 30°C but, like many other developmental rates, this depends very much on host species, temperature and humidity.

On hatching, the first instar, or "crawler", is flat, oval and scale-like. This first instar is the only larval stage of this insect which is mobile. It moves from the egg site to a suitable feeding location on the lower surface of the leaf where its legs are lost in the ensueing moult and the larva becomes sessile. It does not therefore move again throughout the remaining nymphal stages. The first three nymphal stages last 2-4 days each (this could however vary with temperature). The fourth nymphal stage is called the 'puparium', and is about 0.7 mm long and lasts about 6 days; it is within the latter period of this stage that the metamorphosis to adult occurs.

The adult emerges through a "T"-shaped rupture in the skin of the puparium and spreads its wings for several minutes before beginning to powder itself with a waxy secretion from glands on the abdomen. Copulation begins 12-20 h after emergence and takes place several times throughout the life of the adult. The life span of the female could extend to 60 days. The life of the male is generally much shorter, being between 9 and 17 days. Each female lays up to 160 eggs during her lifetime, although the B biotype has been shown to lay twice as many, and each group of eggs is laid in an arc around the female. Eleven to fifteen generations can occur within one year.

DETECTION AND IDENTIFICATION

Symptoms

Numerous chlorotic spots develop on the leaves of affected plants, which may also be disfigured by honeydew and associated sooty moulds (see Pest significance). Leaf curling, yellowing, mosaics or yellow-veining could indicate the presence of whitefly-transmitted viruses and phytotoxic responses such as a severe silvering of courgette and melon leaves indicating the presence of a B biotype *B. tabaci* infestation, the immature stages being mainly responsible for this symptom (Costa *et al*., 1993). A close observation of the underside of the leaves will show the tiny yellow/white larval scales and in severe infestations, when the plant is shaken, numerous small white adult whiteflies will flutter out and quickly resettle. These symptoms do not appreciably differ from those of *Trialeurodes vaporariorum*, the glasshouse whitefly, which is common throughout Europe.

Morphology

Eggs

Pear-shaped with a pedicel spike at the base, about 0.2 mm long.

Puparium

Flat, irregular oval shape, 0.7 mm long. On a smooth leaf the 'puparium' lacks enlarged dorsal setae but, if the leaf is hairy, two to eight long dorsal setae are present.

Adult

About 1 mm long, the male slightly smaller than the female. The body and both pairs of wings are covered with a powdery, waxy secretion, white to slightly yellowish. Differentiation of whitefly species by means of the adults is difficult, although close observation of adult eye morphology will often show differences in ommatidial arrangements between species. However, at rest *B. tabaci* has wings more closely pressed to the body than *Trialeurodes vaporariorum* which is larger and more triangular in appearance.

The fourth instar/puparium is used to distinguish between *B. tabaci* and *T. vaporariorum* as glasshouse pests. *T. vaporariorum* is "pork-pie shaped", being regularly ovoid, with straight sides (viewed laterally) and in most instances, 12 large, wax setae; *B. tabaci* has an irregular "pancake- like" oval shape, oblique sides and shorter, finer setae. The number of enlarged setae vary with the morphology of the host plant, however, and the two caudal setae are always stout and nearly always as long as the vasiform orifice. The length of caudal setae can be used to identify some *Bemisia* species.

For more information on the identification of *B. tabaci* see Martin (1987).

MEANS OF MOVEMENT AND DISPERSAL

Adults of *B. tabaci* do not fly very efficiently but, once airborne, they can be transported quite large distances by the wind. All stages of the pest are liable to be carried on planting material and cut flowers of host species. The international trade in poinsettia is considered to have been a major means of dissemination within the EPPO region of the B biotype of *B. tabaci*.

PEST SIGNIFICANCE

Economic impact

B. tabaci has been known as a minor pest of cotton and other tropical or semi-tropical crops in the warmer parts of the world and, until recently, has been easily controlled by insecticides. In the southern states of the USA in 1991, however, it was estimated to have caused combined losses of 500 million USD to the winter vegetable crops (Perring *et al.*, 1993) through feeding damage and plant virus transmission. *B. tabaci* is also a serious pest in glasshouses in North America and Europe.

The feeding of adults and nymphs causes chlorotic spots to appear on the surface of the leaves. Depending on the level of infestation, these spots may coalesce until the whole of the leaf is yellow, apart from the area immediately around the veins. Such leaves are later shed. The honeydew produced by the feeding of the nymphs covers the surface of the leaves and can cause a reduction in photosynthetic potential when colonized by moulds. Honeydew can also disfigure flowers and, in the case of cotton, can cause problems in processing the lint. With heavy infestations, plant height, number of internodes and quality and quantity of yield can be affected (e.g. in cotton). The larvae of the B biotype of *B. tabaci* are unique in their ability to cause phytotoxic responses to many plant and crop species. These include a severe silvering of courgette leaves, white stems in pumpkin, white streaking in leafy brassica crops, uneven ripening of tomato fruits, reduced growth, yellowing and stem blanching in lettuce and kai choy (*Brassica campestris*) and yellow veining in carrots and *Lonicera* (Bedford *et al.*, 1994a, 1994b).

B. tabaci is the vector of over 60 plant viruses in the genera *Geminivirus*, *Closterovirus*, *Nepovirus*, *Carlavirus*, *Potyvirus* and a rod-shaped DNA virus (Markham *et al.*, 1994). The geminiviruses are by far the most important agriculturally, causing yield losses to crops of between 20 and 100% (Brown & Bird, 1992). Geminiviruses cause a range of different symptoms which include yellow mosaics, yellow veining, leaf curling, stunting and vein thickening. Presently a million ha of cotton is being decimated in Pakistan by cotton leaf curl bigeminivirus (CoLCV) (Mansoor *et al*., 1993), and important African subsistence crops such as cassava are affected by geminiviruses such as cassava African mosaic bigeminivirus (ACMV). Tomato crops throughout the world are particularly susceptible to many different geminiviruses, and in most cases exhibit yellow leaf curl symptoms. Most of these epidemics in the Old World are attributed to tomato yellow leaf curl bigeminivirus (TYLCV) but may also be caused by other geminiviruses. TYLCV has also recently been recorded in the New World, but several other, exclusively American, tomato geminiviruses have now been described, e.g. tomato mottle bigeminivirus (EPPO/CABI, 1996). Tobacco leaf curl (TLCV), watermelon chlorotic stunt (WCSV), squash leaf curl (SLCV) and bean golden mosaic (BGMV) bigeminiviruses also cause heavy yield losses in their respective hosts. Dual infections have also been shown to occur. Several of these viruses are now quarantine pests for the EPPO region (e.g. bean golden mosaic, squash leaf curl, tomato mottle bigeminiviruses, and lettuce infectious yellows closterovirus, which are on the EPPO A1 list; tomato yellow leaf curl bigeminivirus, which is on the EPPO A2 list (EPPO/CABI, 1996).

The emergence of the B biotype of *B. tabaci*, with its ability to feed on many different host plants has given whitefly-transmitted viruses the potential to infect new plant species. This has already been shown to have occurred in the Americas.

Europe has three known geminiviruses within this group. Two have been shown to be no longer transmissible by *B. tabaci*, tobacco leaf curl bigeminivirus and abutilon mosaic bigeminivirus, possibly through many years of vegetative propagation of their ornamental host plants (Bedford *et al*., 1994a). The other is the readily transmissible tomato yellow leaf curl bigeminivirus that is causing major crop losses within the tomato industries of Spain and Italy. The possibility exists that indigenous weed species may also be reservoirs for this and other yet to be identified geminiviruses within Europe. A newly identified *B. tabaci*-transmitted closterovirus is now reported to be causing severe damage to cucumbers and melons in Spain (E. Cerezo, pers. comm.).

Control

Until recently, *B. tabaci* was readily controlled with insecticides in field and glasshouse situations. However, problems with its effective control on many crops are now being experienced worldwide due to insecticide resistance and the increased fecundity of the B biotype. It appears that no single control treatment can be used on a long-term basis against this pest and that the integration of a number of different control agents needs implementing for an effective level of control (integrated pest management). Each area where *B. tabaci* problems are occurring needs assessing individually and an appropriate IPM programme specifically designed. For example, the use of biological control agents alone, such as *Encarsia formosa* and *Verticillium lecanii*, although moderately successful (Nedstam, 1992), can never bring infestation levels of *B. tabaci* down to a level that stops virus transmission. The use of resistant crops needs to be investigated. Future control methods involving a disruption of the vector-virus-host plant cycle are presently under investigation.

Phytosanitary risk

EPPO (OEPP/EPPO, 1989) has listed *B. tabaci* as an A2 quarantine pest, and it is also a quarantine pest for CPPC. The risk to the EPPO region is primarily to the glasshouse industry in northern countries, and mainly concerns the B biotype (though it is difficult in practice to confirm this in specific cases). Since its recent introduction to several of these countries, the pest has proved particularly difficult to combat because of its polyphagy, its resistance to many insecticides and its disruption of biological control programmes (Della Giustina *et al*., 1989). Very few countries remain free from *B. tabaci*, illustrating the difficulty of preventing its movement in international trade. Furthermore, it is likely that it is already present, but unreported, as a pest of field crops, in other countries in the south of the EPPO region. In addition, the "B biotype" may now displace other biotypes on outdoor crops in southern Europe and cause much greater problems.

PHYTOSANITARY MEASURES

Because of the difficulty of detecting low levels of infestation in consignments, it is best to ensure that the place of production is free from the pest (OEPP/EPPO, 1990). Particular attention is needed for consignments from countries where certain *B. tabaci*-listed viruses, now on the EPPO A1 or A2 quarantine lists, are present.

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