EPPO Datasheet: *Scirtothrips dorsalis*

Last updated: 2023-09-13

IDENTITY

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Preferred name: *Scirtothrips dorsalis*
Authority: Hood
Taxonomic position: Animalia: Arthropoda: Hexapoda: Insecta: Thysanoptera: Thripidae
Other scientific names: *Anaphothrips andreae* Karny, *Anaphothrips dorsalis* Hood, *Anaphothrips fragariae* (Girault), *Heliothrips minutissimus* Bagnall, *Neophysopus fragariae* Girault, *Scirtothrips dorsalis var. padmae* Ramakrishna
Common names: Assam thrips, chilli thrips, flower thrips, strawberry thrips, yellow tea thrips
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EPPO Categorization: A2 list
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EU Categorization: A1 Quarantine pest (Annex II A)
EPPO Code: SCITDO

Notes on taxonomy and nomenclature

Scirtothrips dorsalis was described by Hood (1919) from 34 females collected by Ramakrisna in 1916 in Coimbatore (India) on "castor and chillies" shoots. Mound (1968) recognised *Heliothrips minutissimus* Bagnall from Bombay as the same species, and Jacot-Guillarmod (1971) also lists *Anaphothrips andreae* Karny and *S. dorsalis* var. *padmae* Ramakrishna as synonyms. Moreover, the strawberry thrips from Australia, *S. fragariae* (Girault), is recognised as *S. dorsalis* after studying Girault's material by Mound & Palmer (1981). *S. oligochaetus* (Karny), which has been regarded by several authors as the same species as *S. dorsalis*, was recognised by Mound & Palmer (1981) as a distinct valid species. But in view of the confusion between these two species, old published records from India may require confirmation. Based on molecular techniques (sequences of the ITS1 and ITS2 regions), Rugman-Jones *et al*. (2006) suggested that Indian and South African specimens of *S. dorsalis* (identified morphologically) might not be the same species. This was further confirmed by Hoddle *et al*. (2008). Dickey *et al*. (2015), using DNA barcode library and seven nuclear markers via next-generation sequencing, reported the delimitation of nine cryptic species and two morphologically distinguishable species comprising the *S. dorsalis* species complex. One of these, designated as “South Asia 1” which is native to India, is considered highly invasive (e.g. in Japan, Israel, USA). Two other species, “South Asia 2”, and “East Asia 1” are regarded by Dickey *et al*. (2015) as highly polyphagous, but at an earlier stage of global invasion. The other members of the complex are regionally endemic and vary in their pest status and level of polyphagy. The existence of several morphologically indistinguishable species raises practical questions regarding the quarantine status of this species. In the following, the term *Scirtothrips dorsalis* should be understood as *Scirtothrips dorsalis* complex, considering that the currently available literature on this species does not distinguish between the different cryptic species.

HOSTS

S. dorsalis is reported to be highly polyphagous, feeding on more than 100 species in 40 different plant families.

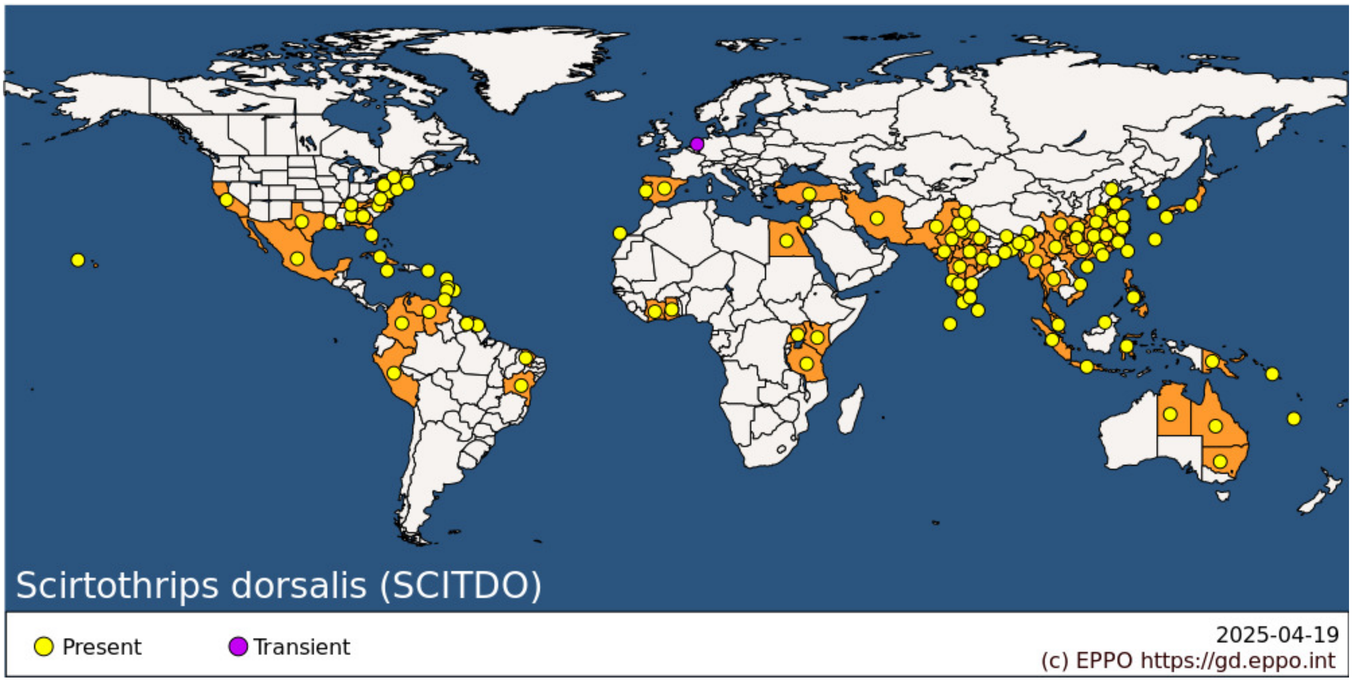
Native host plants include various Fabaceae, such as *Acacia*, *Brownea*, *Mimosa* and *Saraca*. *S. dorsalis* is known as a pest on many crops including kiwi (*Actinidia chinensis)*, *Arachis*, *Capsicum*, *Citrus*, cotton (*Gossypium hirsutum*), strawberry (*Fragaria* x *ananassa)*, grapevine (*Vitis vinifera*), *Hevea brasiliensis*, *Hydrangea*, mango (*Mangifera indica)*, *Nelumbo*, onions (*Allium cepa*), *Ricinus*, *Rosa*, tamarinds (*Tamarindus indica*) and tea (*Camellia sinensis*). *S. dorsalis* is only cited as a significant pest of *Citrus* in Japan and Taiwan. However, members of the cryptic species complex may have reduced host ranges compared to the whole complex (Dickey *et al*., 2015).

Host list: *Abelia x grandiflora*, *Abelmoschus esculentus*, *Acacia*, *Acalypha chamaedrifolia*, *Acalypha hispida*, *Acalypha indica*

, *Acalypha macrostachya*, *Actinidia chinensis*, *Allamanda cathartica*, *Allium cepa*, *Allium sp.*, *Almeidea rubra*, *Amaranthus spinosus*, *Anacardium occidentale*, *Antirrhinum majus*, *Apium graveolens*, *Arachis hypogaea*, *Ardisia compressa*, *Azadirachta indica*, *Barringtonia racemosa*, *Begonia sp.*, *Begonia tuberhybrida hybrids*, *Berberis bealei*, *Bougainvillea spectabilis*, *Bremeria pervillei*, *Brexia madagascariensis*, *Breynia disticha*, *Brownea sp.*, *Bruguiera sp.*, *Caladium sp.*, *Camellia japonica*, *Camellia sasanqua*, *Camellia sinensis*, *Campanula carpatica*, *Capparis erythrocarpos*, *Capsicum annuum*, *Capsicum frutescens*, *Carica papaya*, *Catunaregam spinosa*, *Ceiba pentandra*, *Celosia argentea var. plumosa*, *Celosia argentea*, *Chrysanthemum sp.*, *Citroncirus Citrumelo hybrids*, *Citroncirus webberi*, *Citroncirus*, *Citrus medica*, *Citrus reshni*, *Citrus trifoliata*, *Citrus x aurantiifolia*, *Citrus x aurantium var. clementina*, *Citrus x aurantium var. paradisi*, *Citrus x aurantium var. sinensis*, *Citrus x aurantium var. unshiu*, *Citrus x aurantium*, *Citrus x latifolia*, *Citrus x limon var. meyerii*, *Citrus x limon*, *Citrus*, *Clitoria javitensis*, *Codiaeum variegatum*, *Coleus scutellarioides*, *Colocasia esculenta*, *Conocarpus erectus*, *Coreopsis sp.*, *Coriandrum sativum*, *Cosmos caudatus*, *Crassula ovata*, *Crinum purpurascens*, *Crossandra infundibuliformis*, *Crossandra massaica*, *Cucumis sativus*, *Cuphea sp.*, *Dahlia sp.*, *Daucus carota*, *Desmanthus sp.*, *Dieffenbachia seguine*, *Dimocarpus longan*, *Dimorphotheca ecklonis*, *Dioscorea alata*, *Diospyros kaki*, *Diplocyclos palmatus*, *Dissotis rotundifolia*, *Duranta erecta*, *Echinacea purpurea*, *Echinochloa colonum*, *Eclipta prostrata*, *Ehretia cymosa*, *Embelia procumbens*, *Epipremnum pinnatum*, *Euadenia eminens*, *Eucalyptus deglupta*, *Euphorbia hypericifolia*, *Euphorbia pulcherrima*, *Eustoma russellianum*, *Ficus elastica*, *Ficus exasperata*, *Ficus lingua*, *Fittonia albivenis*, *Fortunella*, *Fragaria x ananassa*, *Garcinia livingstonei*, *Garcinia mangostana*, *Gardenia jasminoides*, *Gardenia thunbergia*, *Gerbera jamesonii*, *Gerbera sp.*, *Glandularia sp.*, *Glycine max*, *Gnetum costatum*, *Gossypium barbadense*, *Gossypium hirsutum*, *Gossypium sp.*, *Hedera helix*, *Heptapleurum arboricola*, *Hevea brasiliensis*, *Hevea sp.*, *Hibiscus arnottianus*, *Hibiscus liliiflorus*, *Hibiscus rosa-sinensis*, *Hydrangea*, *Iguanura geonomiformis*, *Illicium floridanum*, *Impatiens hawkeri*, *Impatiens walleriana*, *Jasminum sambac*, *Justicia extensa*, *Lagerstroemia indica*, *Laguncularia racemosa*, *Lantana camara*, *Lawsonia inermis*, *Lebronnecia kokioides*, *Leea guineensis*, *Lepidium sativum*, *Licuala grandis*, *Ligustrum japonicum*, *Ligustrum sp.*, *Litchi chinensis*, *Ludwigia hyssopifolia*, *Lysimachia ruhmeriana*, *Malpighia glabra*, *Mangifera indica*, *Manihot esculenta*, *Manilkara zapota*, *Markhamia zanzibarica*, *Mimosa pudica*, *Mimosa*, *Mitriostigma axillare*, *Monanthotaxis obovata*, *Morus alba*, *Murraya koenigii*, *Murraya paniculata*, *Napoleonaea vogelii*, *Nelumbo nucifera*, *Ocimum basilicum*, *Odontonema tubaeforme*, *Oenothera lindheimeri*, *Oncoba spinosa*, *Paeonia officinalis*, *Palisota mannii*, *Passiflora edulis*, *Passiflora foetida*, *Pavetta revoluta*, *Pelargonium graveolens*, *Pelargonium x hortorum*, *Pentas lanceolata*, *Persea americana*, *Petunia hybrids*, *Phaseolus vulgaris*, *Phyllanthus niruri*, *Phyllanthus urinaria*, *Pittosporum senacia*, *Pittosporum tobira*, *Plerandra elegantissima*, *Plumbago auriculata*, *Plumeria rubra*, *Polyscias ornifolia*, *Pouteria campechiana*, *Psidium guajava*, *Punica granatum*, *Pyrus communis*, *Quisqualis indica*, *Ramosmania rodriguesii*, *Rhaphiolepis indica*, *Rhaphiolepis umbellata*, *Rhododendron sp.*, *Richardia brasiliensis*, *Ricinus communis*, *Rosa sp.*, *Rosa*, *Rotheca myricoides*, *Rubus idaeus*, *Rubus sp.*, *Salvia farinacea*, *Salvia officinalis*, *Sanchezia oblonga*, *Saraca indica*, *Scindapsus pictus*, *Selenicereus undatus*, *Sesbania herbacea*, *Solanum lycopersicum*, *Solanum melongena*, *Solanum tuberosum*, *Stereospermum nematocarpum*, *Strobilanthes auriculata var. dyeriana*, *Strobilanthes maculata*, *Synsepalum dulcificum*, *Syzygium sp.*, *Tabernaemontana divaricata*, *Tagetes erecta*, *Tagetes patula*, *Tamarindus indica*, *Tarenna alleizettei*, *Tarenna alpestris*, *Tecoma fulva*, *Tephrosia vogelii*, *Terminalia boivinii*, *Terminalia mantaly*, *Terminalia neotaliala*, *Theobroma cacao*, *Thunbergia erecta*, *Thunbergia vogeliana*, *Tradescantia zebrina*, *Trichilia havanensis*, *Trilepisium madagascariense*, *Trimezia lutea*, *Turraea floribunda*, *Vaccinium corymbosum*, *Vaccinium darrowii*, *Vaccinium myrtillus*, *Vaccinium*, *Viburnum odoratissimum*, *Viburnum suspensum*, *Vigna radiata*, *Viola x wittrockiana*, *Vitis vinifera*, *Zinnia elegans*, *Zinnia x marylandica*, *x Citrofortunella microcarpa*

GEOGRAPHICAL DISTRIBUTION

S. dorsalis is presumed to originate in Asia but its exact area of origin is unclear, with different origins proposed by different authors, ranging from South Asia to the Indian subcontinent or from Pakistan in the west to Japan and Queensland in the east, or from Australasia, or part of Africa. The distribution of *S. dorsalis* has expanded globally over recent years with spread in the Americas, Africa and now the EPPO region. The understanding of the native distribution is further complicated by the fact that *S. dorsalis* is a cryptic species complex containing morphologically indistinguishable species (see Notes on taxonomy and nomenclature).



EPPO Region: Israel, Netherlands, Portugal (mainland), Spain (mainland, Islas Canárias), Türkiye
Africa: Cote d'Ivoire, Egypt, Ghana, Kenya, Tanzania, United Republic of, Uganda
Asia: Bangladesh, Brunei Darussalam, China (Anhui, Beijing, Chongqing, Fujian, Guangdong, Guangxi, Guizhou, Hainan, Henan, Hubei, Hunan, Jiangsu, Jiangxi, Shandong, Sichuan, Xianggang (Hong Kong), Yunnan, Zhejiang), India (Andhra Pradesh, Arunachal Pradesh, Assam, Chhattisgarh, Delhi, Goa, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Odisha, Punjab, Rajasthan, Sikkim, Tamil Nadu, Uttarakhand, Uttar Pradesh, West Bengal), Indonesia (Java, Sulawesi, Sumatra), Iran, Islamic Republic of, Israel, Japan (Honshu, Kyushu, Ryukyu Archipelago), Korea, Republic of, Malaysia (West), Maldives, Myanmar, Pakistan, Philippines, Sri Lanka, Taiwan, Thailand, Vietnam
North America: Mexico, United States of America (Alabama, California, Florida, Georgia, Hawaii, Louisiana, Maryland, Massachusetts, New Jersey, New York, North Carolina, Pennsylvania, Rhode Island, Tennessee, Texas, Virginia)
Central America and Caribbean: Barbados, Cuba, Guadeloupe, Jamaica, Puerto Rico, Saint Lucia, Saint Vincent and the Grenadines, Trinidad and Tobago
South America: Brazil (Bahia, Ceara), Colombia, French Guiana, Peru, Suriname, Venezuela
Oceania: Australia (New South Wales, Northern Territory, Queensland), New Caledonia, Papua New Guinea, Solomon Islands

BIOLOGY

Scirtothrips dorsalis life cycle includes 6 stages (egg, first and second instar larva, prepupa, pupa and adult) and it reproduces both sexually and parthenogenically (unfertilized eggs produce males). Development is directly influenced by temperature, moisture, and the type of host it is feeding on. *S. dorsalis* produces a highly variable number of generations per year, depending on the climatic conditions of the region. From four to eight generations in temperate areas of Japan according to Seal *et al*. (2010) but only three to four in nursery conditions at 25°C (Arthurs *et al*., 2013) or 14-18 generations per year projected by Holtz (2006), using a degree-day model in Florida. In Central Japan, adults overwinter in litter and soil, but also on leaves and branches (Okada, 1982) whereas in India, no diapause is observed (Toda *et al*., 2014). In Japan and South Korea overwintered adults become active from early March, and move to the leaf zone. After feeding on and laying eggs into new leaves, the adults of the first generation die between end of April and mid-May. The mean incubation time of *S. dorsalis* eggs is between 7 et 10 days (Tatara, 1994; Seal *et al*., 2010). Based on Tatara (1994), the developmental zero temperature and the maximum temperature threshold for the development from oviposition to adult emergence is 9.7 and 33.0°C, respectively with an accumulative temperature of 265 degree-days. Larvae and adults feed particularly on young, developing tissue including shoots, leaves, young fruit, and flowers. Pupae (a quiescent stage) are found in the leaf litter, in leaf axils, in curled leaves, or under the calyx of flowers and fruits. Because of the length of the oviposition period (about 13 days), from the third generation, there are overlapping generations. The combined larval and pupal periods ranged from 11 days to 13 days and the lifespan of females is about 19 days and slightly less for males (in laboratory conditions) (Seal *et al*., 2010).

DETECTION AND IDENTIFICATION

Symptoms

In common with several other members of the genus, this species can cause major damage to infested plants. Leaves curl and exhibit characteristic silvering of the leaf surface and linear thickening of the leaf lamina (Kumar *et al*., 2021a) with premature senescence and abscission of leaves. Fruits have grey to black markings or distortion. These symptoms are often associated with brown frass markings on the leaves and fruits. On groundnuts (peanuts), dull yellowish-green patches form on the upper surface of leaves and brown necrotic areas and silvery sheen on the lower surfaces (Hodges *et al*., 2005). On celery, affected plants exhibited light to dark brownish scars on various parts. The leaves are discoloured and distorted (Kumar & Rachana, 2021). On Citrus, fruits show ring scarring around the stem and dark brown discolouring (Hyun *et al*., 2012). *S. dorsalis* is also a vector of plant viruses, for example the groundnut yellow spot virus, GYSV (Kumar *et al*., 2013) which has symptoms that include yellow chlorotic spots on partially/fully opened growing buds. The infected seedlings and leaflets are reduced in size (Gopal *et al*., 2010).

Morphology

The 108 species of the pantropical genus *Scirtothrips* are difficult to distinguish because they are small (about 1mm), and usually pale yellow or white in colour. Good slide-mounted specimens and the use of a differential interference microscope are recommended in order to observe minute details of structure, such as microtrichia and sculpture, that are essential for precise identification (Ng *et al*., 2014). The EPPO Diagnostic Protocol for *S. aurantii, S. citri* and *S. dorsalis* provides recommendations on how to detect and identify the pest (EPPO Standard PM 7/56, 2005).

Alternatively, molecular tools are available for diagnostics. Rugman-Jones *et al*. (2006) developed a molecular key to pestiferous *Scirtothrips* species (including *S. dorsalis*) based on the internal transcribed spacer regions 1 and 2 (ITS1 and ITS2) of nuclear ribosomal DNA. Toda *et al*. (2014) designed a multiplex PCR-based molecular test for two Japanese ‘strains’ by using the differences in their ITS2 sequences that correspond to four cryptic species according to Dickey *et al*. (2015). Seepiban *et al*. (2015) also described a procedure for the simultaneous identification of tospoviruses and thrips species (incl. *S. dorsalis*) based on testing of individual thrips.

Egg

The eggs are microscopic (0.075 mm long and 0.070 mm wide), smooth and reniform and creamy white.

Larva

Larvae are creamish white to almost white. The sizes of the first instars and second instars range between 0.37-0.39 and 0.68-0.71 mm respectively (Kumar *et al.*, 2013). A key to differentiate the second instar of *S. dorsalis* among the most commonly encountered Western Palaearctic species (and also some species of quarantine interest) using a microscope (with phase contrast) is available (Vierbergen *et al*., 2010).

Pupa

Thrips are characterized in having two quiescent immature stages known as propupa and pupa between the larval and adult stages. Their size range between 0.55 and 0.80 mm (Duraimurugan & Jagadish, 2011; Seal *et al*., 2010). The propupa and pupa are yellow. Their antennal segmentation is reduced but the pupa has backward-curved antennae above its head. The mouth parts are non-functional. Wing pads can be seen in the propupa, reaching only up to the third abdominal segment, but are much longer in the pupa.

Adult

Members of the genus *Scirtothrips* are readily distinguished from all other Thripidae by the following characters:

surface of pronotum covered with many closely spaced transverse striae; abdominal tergites laterally with numerous parallel rows of tiny microtrichia; sternites with marginal setae arising at posterior margin; metanotum with median pair of setae arising near anterior margin. The only closely similar genus is *Drepanothrips* (with only one species, *D. reuteri)*, a native European pest of grapevine, but that has 6-segmented antennae instead of 8-segmented.

Detection and inspection methods

Because of their small size, their pale colour and their behavioural responses (thigmotaxis), *Scirtothrips* species are easily overlooked if the import inspection is carried out visually. Only heavily infested plants are likely to be detected by visual examination. However, high infestations are rarely the case in the context of import control. So the detection of thrips is more effective with the use of a Berlese funnel (thrips move down into the funnel to escape desiccation and are captured in a jar) allowing fast extraction of adults and larvae within 48h in port and airport facilities. A plastic cup trap (as described by Chu *et al*., 2006) can also collect intact *S. dorsalis* specimens. The use of coloured sticky traps, even if this system is easy to operate, is not recommended because thrips are difficult to extract and are often no longer recognizable.

For early detection of introductions, EFSA (2020) recommends surveillance in facilities that process imported commodities originating from areas where the pest is present, i.e. cut flowers, *Vaccinium* plants for planting, *Camellia sinensis* plants for planting and *C. annuum* fruit.

PATHWAYS FOR MOVEMENT

The potential of *Scirtothrips* spp. to move long distances is relatively limited by the size of adults, which move passively with air currents. Long distance spread is only expected through international trade of infested commodities (for example: plants for planting, fruits and vegetables as well as fresh cut flowers and foliage) that may go undetected. An incubation period of 6 or 7 days is also sufficiently long to allow *S. dorsalis* eggs in air cargo shipments from infested regions to airports in pest-free countries to pass through quarantine check points without detection (Seal *et al*., 2010). Moreover, interceptions in consignments from Africa or Asia are not rare (Anses, unpublished data, 2023; Holtz, 2006; Farris *et al*., 2010, EFSA 2014) and as highlighted by Dickey *et al.* (2015), several cryptic species within the complex appear to be invasive (see “Notes on taxonomy and nomenclature” for more details). Even if the risks of cross-border transport are considered as high for air passengers, crew and their baggage by Meissner *et al*. (2005), this means of dispersal is not documented elsewhere in the literature. The survival of adults on non-plant supports followed by a dispersal to a suitable host plant seems to be questionable.

The risk of movement with host fruit, vegetables, cut flowers/foliage depends mainly on the risk of transfer to host plants at destination. It is low when the commodities are distributed directly to the final consumer (e.g. fruits or leafy vegetables packed in the country of origin). There may be a risk of transfer if these products are stored in contact with plants for planting at destination, as may be the case for cut flowers that are sold in garden centres. Vegetables that are underground parts of host plants (e.g. potato or taro) are not considered as a pathway if no soil is attached to them.

PEST SIGNIFICANCE

Economic impact

In its principal range in Tropical Asia, *S. dorsalis* is mainly a serious pest of herbaceous plants: vegetables in Taiwan and Thailand, *Capsicum*, groundnuts and onions in India, cotton in India and Pakistan. It is also a pest of flowers, for example of roses in India. In Malaysia, it is a pest of the flowers and leaves of *Hevea brasiliensis*. *S. dorsalis* has become the foremost pest in Indian tea plantations (Deka *et al*., 2020) and infestation can result in 11-17% crop loss (Varatharajan *et al*., 2019). In Japan and Taiwan, *Citrus* (especially *C. unshiu*) is seriously affected (Tatara & Furuhashi, 1992) while in Iran, *S. dorsalis* is locally very abundant on *Citrus* (Minaei *et al*., 2015). In Japan and Australia, *S. dorsalis* is also a pest of grapevine (Shibao *et al*., 1991; Mound *et al*., 2022). It was also found in kiwi orchards In Japan, but without causing damage to the fruits (Sakakibara & Nishigaki, 1988). In 2020 large populations of *S. dorsalis* were reported near Perth in Western Australia causing considerable damage to rose plants, and in India, loss by thrips feeding on roses results in 28-95 % damage (Gahukar, 2003 *in* Sridhar & Naik, 2015). *S. dorsalis* has become one of the key pests causing economic damage to the fruit production of mango in Taiwan (Lin *et al*., 2015) greatly affecting the market price and export potential. According to Kumar & Rachana (2021), *S. dorsalis* causes economic damage in India to cassava, chilli (with yield loss up to 74% [Patel *et al*., 2009 *in* Kumar & Rachana 2021]), groundnut, rose, taro (*Colocasia esculenta*), and tea. In Florida, it has become an economically important pest of ornamental plants (Seal *et al*., 2010). An economic analysis performed in 2004 in the USA (Garret, 2004 *in* Holtz, 2006), based on a hypothesis of 5 percent crop yield loss to 28 hosts of *S. dorsalis*, would result in 3 billion USD in potential losses and up to 6 billion USD for a 10 percent crop yield loss. *S. dorsalis* is also an important vector of Orthotospoviruses (Mound *et al*., 2022) including chilli leaf curl virus (CLCV), Groundnut bud necrosis virus (GBNV), Groundnut chlorotic fan-spot virus (GCFSV), Groundnut yellow spot virus (GYSV), tobacco streak virus (TSV), Capsicum chlorosis virus (CaCV), Melon yellow spot virus (MYSV), Watermelon silver mottle virus (WSMoV) (Seal *et al*., 2010; Riley *et al*., 2011; Rotenberg *et al*., 2015).

Control

Current management of *S. dorsalis* is mainly based on chemical control (Kaur *et al*., 2023) and many studies highlight the efficacy of selected insecticides. Imidacloprid, spinetoram, thiamethoxam, fipronil, acetamiprid and spinosad are frequently reported as effective for reducing thrips populations (Seal *et al*. 2006; Patel & Kumar, 2017; Samota *et al*., 2017; Deka *et al*., 2020; Lahiri & Panthi, 2020; Panthi *et al*., 2020; Babu *et al*., 2021; Lakshmi & Kumar 2021). But numerous other active ingredients are used for the control of this pest in Southern India (buprofezin, indoxacarb, triazophos, tolfenpyrad, pymetrozine, etc.). However, application of certain products by growers on calendar basis may lead to the development of insecticide resistance (Kaur *et al*., 2023). In South-East Asia, resistance among populations of *S. dorsalis* is documented to various insecticide modes of action, including organophosphates, organochlorines and carbamates (Seal & Kumar, 2010). Recent results of Kaur *et al*. (2023) also indicate potential emergence of resistance to several newer active substances from the spinosyn, diamide and neonicotinoid families.

Biological control can be used as an alternative strategy for the control of thrips and there are many examples of successful biological control, but few studies relating directly on *S. dorsalis*. The potential use of mycoinsecticides on vegetables or ornamental plants has been assessed for this species by different authors, in laboratory conditions, in greenhouses tests or in field trials, with a high variability of results (Seal & Kumar, 2010; Arthurs *et al*., 2013; Panyasiri *et al*., 2022). For example, in greenhouses, environmental conditions (high humidity and low UV exposure) can be manipulated to favour entomopathogenic fungi while in fields, regular rainfall may wash away the fungal suspension. *Heterorhabditis indica* (Nematoda: Rhabditida) or *Thripinema* spp. (Nematoda: Tylenchida) are entomopathogenic nematodes reported to effectively control field populations of *S. dorsalis* according to Jagdish & Purnima (2011) and Kumar *et al*. (2021a). But reliable results are lacking in the literature, and their effectiveness has yet to be consolidated by additional results. Predatory mites have been used against some thrips species in greenhouse vegetables and ornamentals for many years with some success and more recently on *S. dorsalis*. The efficacy of *Amblyseius swirskii* is considered as more effective than *Neoseiulus cucumeris* on peppers by Arthurs *et al.* (2009) and Do?ramaci *et al.* (2011) confirmed that *A. swirskii* is an effective predator. Other candidate predators include anthocorid and mirid bugs, syrphids, some gall midges, lacewing larvae, spiders, sphecid wasps, predatory thrips and pseudoscorpions (Holtz, 2006; Varatharajan *et al*., 2019). But further studies are required before any attempt is made of augmentation and conservation of predators in IPM programmes. Almost nothing is known about parasitoids of *S. dorsalis*. The egg parasitoid *Megaphragma* sp. (Hymenoptera: Trichogrammatidae) was reported in Japan by Shibao *et al*. (2000) as not effective for controlling the population density of *S. dorsalis* on grapes. Some *larval* endoparasitoids of the eulophid family are also listed by Varatharajan *et al*. (2019) from India but their effect on *S. dorsalis* populations is not documented.

Phytosanitary risk

S. dorsalis is mainly a tropical species, but its occurrence in citrus-growing areas with a subtropical climate suggests that it could possibly establish on citrus in Southern Europe and the Mediterranean area, as this was confirmed by the recent introduction of *S. dorsalis* in Southern Spain in 2017. Based on niche modelling, de Aguiar *et al.* (2023) estimated the potential projected suitability in Europe as low, probably due to low temperatures. However, the model projected at risk areas in Portugal, the west coast of Spain, South-West France, a coastal region from Croatia to Greece, and the west coast of Turkey and surprisingly the west coast of the United Kingdom. The host range of *S. dorsalis* includes a number of vegetable crops, and the possibility of introduction onto glasshouse crops in Europe should be considered. The EFSA Panel on Plant Health (2014) highlighted that there are three main pathways for introduction of *S. dorsalis* into the EU: plants intended for planting, cut flowers and fruits and vegetables of host species. They noted that host plants are very widely distributed in the EU and therefore do not represent a limiting factor for its establishment.

PHYTOSANITARY MEASURES

Importation of *Citrus* plants for planting is prohibited or restricted in many EPPO countries to prevent introduction of important pests. However, *S. dorsalis* could be introduced with other plant species, as it is very polyphagous, and adults may be found on plants on which they may not complete their full life cycle. To prevent introduction of the pest, plants for planting should either be dormant (i.e., without leaves) with no growing medium attached or come from a pest-free area or a pest-free place of production. An insecticide treatment before shipping may also be an option.

Appropriate measures should be applied to host fruit, vegetables, cut flowers/foliage to ensure that they are pest-free.

In case of a rapid detection after an introduction under protected conditions, the chance of eradication would be high by using phytosanitary measures including prohibition of movement of plants within and out of the place of production, and the destruction of the lot with the infested plants. The prospects are better if the species cannot survive outdoors.

REFERENCES

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