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THE CHILLI THRIPS, SCIRTOTHRIPS DORSALIS: CURRENT STATUS IN THE GREATER CARIBBEAN REGION

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ABSTRACT. In 2003 the chilli thrips, Scirtothrips dorsalis, which originated in southern Asia, was found to be established in St. Vincent and the Grenadines. Now its current known distribution in the Greater Caribbean Region is Barbados, Florida, Jamaica, Puerto Rico, Texas, Trinidad & Tobago, St. Lucia, St. Vincent, Venezuela and Suriname. It appears to be absent from the French West Indies, Guyana, Hispaniola and Costa Rica. In 1995 S. dorsalis was found on flowers in the baggage of a passenger from El Salvador to the USA, but there is no recent evidence to suggest that the pest is established in El Salvador or in any Central American country or in Cuba. In 2004, the pest was found attacking eggplant (Solanum melongena), pepper (Capsicum spp.), okra (Abelmoschus esculentus) and cucurbits in Trinidad. In the recent past the pest reached damaging levels on hot peppers in St. Lucia and St. Vincent, on carrot, sea island cotton, and sweet potato in Barbados, on mango in Puerto Rico and on roses in Texas and on numerous ornamental landscape plantings in Florida. It is still not an economic problem on vegetable and tropical fruit crops in Florida, although it was damaging in strawberry fields in 2006. In Texas, S. dorsalis is still being found on plants in retail garden centers and it has been detected on one residential property in the Houston area. Interceptions of S. dorsalis at US ports of entry have become infrequent. From January 2007 to June 2008, only three interceptions of S. dorsalis were made at US ports of entry, which indicates that the industry and regulatory officials in infested countries which export into the US market are taking effective actions. Recent advances on the biology and control of this pest are mentioned briefly.

KEY WORDS: distribution in Greater Caribbean, ornamental, tropical fruit and vegetable crops, carrot, cotton, mango, pepper, sweetpotato

RESUMEN

LOS THRIPS DE LOS CHILES, SCIRTOTHRIPS DORSALIS: ESTADO ACTUAL EN LA MAYOR REGIÓN DEL CARIBE

EXTRACTO. En el 2003 el thrip de los chiles, Scirtothrips dorsalis se originaron en Asia Meridional, fueron encontrados para ser establecidos en San Vincente y las Granadinas. Ahora su distribución se conoce actualmente en la mayor región del Caribe como Barbados, la Florida, Jamaica, Puerto Rico, Tejas, Trinidad; Trinidad Tobago, Sta. Lucía, San Vincente, Venezuela y Suriname. Aparece ser ausente en Las Antillas francesas, Guyana, La Espanola y Costa Rica. En 1995 S. dorsalis fue encontrado en unas flores dentro de las maletas de un pasajero que viajaba de El Salvador a los Estados Unidos de America, pero no hay evidencia reciente para asegurar que el parasito fue establecido en El Salvador o en otro País de Centroamerica o en Cuba. En el 2004 el parásito fue econtrado atacando a la berenjena (Solanum melongena), pimiento

(Capsicum spp.), Okra (Abelmoschus esculentus) y cucúrbitas en Trinidad. En el pasado el parásito alcanzó niveles perjudiciales en los pimientos calientes en Sta. Lucía y San Vincente, la zanahoria, algodón de Isla del Mar, en el boniato dulce(sweet potato) en Barbados, en el mango en Puerto Rico y en las rosas en Tejas y tambien en plantaciones ornamentales numerosas en los Jardines de la Florida. Todavía no es un problema económico en la cosechas de Frutas Tropicales y Vegetales en La Florida, aunque fue perjudicial en campos de la fresa en el 2006. En Tejas, los S. dorsalis. todavía se están encontrando en las plantas en centros de jardínes al por menor y se ha detectado una característica residencial en el área de Houston. Las interceptaciones de los S. dorsalis en los puertos de los U.S.A. la entrada han llegado a ser no frecuentes. En Enero del 2007 a Junio del 2008, solamente tres interceptaciones de los S. dorsalis fueron hechas en la entrada en los puertos de los U.S.A., esto indica que la industria y los funcionarios reguladores en los países infestados que exportan en el Mercado Norteamericano están tomando medidas eficaces. Los avances recientes en la biología y el control de este parásito se mencionan poco.

PALABRAS CLAVES: Distribución Mayor en verdura del Caribe, ornamental, fruta tropical, zanahorias, algodón, mango, pimientos, boniato dulce.

INTRODUCTION

Exactly five years have passed since Dr. T. L. Skarlinsky discovered that Scirtothrips dorsalis, the chilli thrips, had become established and was causing damage in the Caribbean, namely in St. Vincent (Skarlinsky 2003). In May 2003, two months prior to this discovery the Florida Nursery, Growers & Landscape Association (FNGLA) had asked the Major Nursery Pest & Disease Identification Task Force to assemble a short list of pests and pathogens which did not yet occur in Florida, but which once present in the state, would likely cause the greatest economic damage to the nursery and landscape industries. This team compiled a list of 13 exotic organisms dubbed the "Unlucky Thirteen", which includes the chilli thrips, Scirtothrips dorsalis Hood (FNGLA 2003).

Beginning in October 2004 we initiated studies in collaboration with the Ministry of Agriculture and Fisheries, St. Vincent and the Grenadines on the biology, ecology and control of the chilli thrips. In addition we have attempted to determine the geographical distribution of this invasive species within the Greater Caribbean Region.

BASIC BIOLOGY AND DETECTION

S. dorsalis is capable of reproducing both sexually and parthenogenically (Hodges et al. 2005). Adults typically mate 2-3 days after their pupal molt and the females begin to lay eggs 3-5 days after emergence. Females tend to lay eggs continuously with the total number of eggs ranging from 40-68 (Venette and Davis 2004; GPDD 2006). Populations of S. dorsalis under favorable conditions have the capacity to double every 8 or 9 days (Seal et al. 2008).

Eggs are inserted into tender plant tissues. The egg stage lasts one week, which is long enough for an infested flower or fruit to be sent from a producer in Asia and delivered to a consumer in the Greater Caribbean Region–without being detected by an inspector at the port of entry. The immature stages are cryptic and about 1 mm long and the adults are less than 2 mm long. The

odds of detecting the chilli thrips on infested pepper fruits can be increased by 3-fold or more by dislodging them with the Miller-Skarlinsky shaker box.

Larvae and adults feed on meristems and other new plant tissues including new shoots, new leaves, young fruits, and flowers of the host plant, causing damage and spreading disease. Types of damage include browning or blackening of infested plant parts, that may also create stains and scars (Venette and Davis 2004; CABI 2005; Hodges et al. 2005). Severe infestations may lead to deformation and defoliation. The axillary leaf branches tend to sustain the most damage (CABI 2005). S. dorsalis has been known to transmit several plant diseases including Tomato Spotted Wilt Virus, which causes Bud Necrosis Disease in peanuts, Yellow Spot Virus on groundnut, nonviral Chilli Leaf Curl disease (Schall 1995), Peanut Chlorotic Fan Virus, and Peanut Yellow Spot Virus (Amin et al. 1981; Mound and Palmer 1981; Ananthakrishnan 1993).

Although S. dorsalis larvae and adults are almost invisible to the naked eye, their damage is readily recognized because the pest's feeding activity on meristems and other tender tissues causes discoloration, and ugly distortion, upward curling of leaves and defoliation. The adults' dark antennae and transverse dark bands across the abdominal segments are a useful clue in making a preliminary identification.

S. dorsalis is highly polyphagous, feeding on plants in more than 40 plant families, and it has numerous common names including Assam thrips, castor thrips, chilli thrips, chile thrips strawberry thrips, and yellow tea thrips.

PATHWAYS AND SPREAD

S. dorsalis may be spread over large distances through infested commodity shipments. For example in 2003, live larvae and pupae under the calyces of treated peppers arrived at Miami International Airport from St. Vincent and the Grenadines (Skarlinsky 2003). S. dorsalis has been intercepted at U.S. ports of entry on the leaves, fruit, and flowers of 30 different plant species shipped from Asia (USDA-APHIS 2006). The pest was spread throughout Florida on infested potted ornamental plants (Rosa sp.) and Capsicum spp. (pepper) seedlings merchandized by chains of retail garden centers; and this has been the pathway in Texas (Ludwig 2008).

According to an analysis preformed by USDA-APHIS (Meissner et al. 2005), the most important pathways whereby transboundary spread over long distances of S. dorsalis is most likely to occur are as follows:

1. air passengers and crew and their baggage, and cargo,
2. mail, including mail from express mail carriers,
3. infested smuggled material (which cannot be quantified), and
4. windborne dispersal.

The volume of air travel involving the Greater Caribbean Region was very high during the past two decades. For example in 2004, 13 major and 22 minor airlines conducted flights between the Caribbean and the USA. Also the volume of perishable agricultural commodities traded internationally has been doubling every 5 or 6 years (Klassen et al. 2002; Zadig 1999) and 3 million tons of fresh flowers, fruits and vegetables enter Miami each year (Klassen et al. 2002).

In the 3.5 years between Oct. 1, 2001 and Feb. 14, 2005, the number of shipments of agricultural commodities from the Caribbean to the continental USA were as follows: Dominican Republic – 133,921; Haiti - 46,142; Jamaica 5,932, Dominica, 3,083 and Trinidad and Tobago, 2,086, Puerto Rico, 60; St. Vincent and the Grenadines, 26; St. Lucia, 16; Bahamas, St. Kitts and Nevis, and US Virgin Island, each 7; Antigua and Barbuda, 5; Barbados, 3; Curacao, 3; Anguilla, 2; Cayman Islands, 2; Aruba, Cuba, Grenada, Guadeloupe, Martinique, Montserrat, and Turks and Caicos, each 1 (Meissner et al. 2005).

Numerous records of S. dorsalis interceptions at US international airports demonstrate that S. dorsalis life stages in the baggage of passengers readily survive on flights from Asian countries to the USA. Inspectors are not likely to detect S. dorsalis eggs, which are inserted into plant tissues and invisible to the unaided eye, while larvae and pupae are hidden under calyces and in crevices and adults may take flight (Meissner et al. 2005).

Interceptions of various species of thrips in the international mail from various parts of the world occurred 241 times between 1985 and 2004. In one instance live specimens of S. dorsalis survived on live plant material sent by mail from Vietnam to New York. (Meissner et al. 2005).

Infested plants sold to consumers by chains of retail stores were the main pathway whereby S. dorsalis was dispersed throughout Florida in the fall of 2005 and early 2006.

The likelihood that some Scirtothrips dorsalis adults are borne on air currents is very high, because (1) the pest is found primarily on terminal leaves, buds and flowers of host plants (Seal et al. 2006), (2) daily flight activity is greatest between 10 am and 4 pm when the air is the most buoyant and wind gusts are the strongest (Seal et al., 2008), and (3) the pest flies above the canopy of tea and other host plants (Takagi, 1978). Thrips are known to be passively borne long distances in wind currents (Laughlin, 1977; Lewis 1973; 1997).

Meissner et al. (2004) used historical weather data and the modeling methods of Draxler and Rolph (2003) and Magarey et al. (2004) to calculate the trajectories of air currents which moved from St. Lucia to South America, Central America, the eastern Caribbean, Mexico, Cuba, the Bahamas and the continental USA. Of the 122 trajectories studied, the percentage passing over these destinations were South America (40), Central America (31), eastern Caribbean (12), Mexico (6) Cuba (4), the Bahamas (2.6) and the continental USA (4). The average numbers of days that were required for a parcel of air to travel from St. Lucia to these destinations were as follows: South America (1.6), Central America (3.8), eastern Caribbean (4.3), Mexico (6.1), Cuba (3.4), the Bahamas (3.2) and the continental USA (6.2). Desiccation during flight probably would kill most thrips. A study in southern Australia (Laughlin 1977) showed that during the winter with an average temperature range of approximately 10-14°C, thrips could most likely survive in the air without food or water, for over 24 hours, while at summer temperatures of approximately 19-23°C, survival times of airborne thrips were predicted to average 6 hours, and on very hot days only 3 hours. Thus dispersal of viable S. dorsalis on wind currents is unlikely except between closely adjacent land masses; but this may be a very significant pathway within a given land mass.

In the western hemisphere, S. dorsalis was first discovered on St. Lucia and St. Vincent in 2003 (Skarlinsky, 2003; Seal et al., 2006) and in Trinidad in 2004 (MALMR, 2005). S. dorsalis was already very widely dispersed on these islands at the time of first detection, which suggests that dispersion of the pest had been wind-assisted, since the rapid transport of infested plants throughout these mountainous islands by people seems unlikely.

ECONOMIC IMPORTANCE

The native host plants of S. dorsalis are believed to be various Fabaceae including Acacia, Brownea, Mimosa and Saraca (CABI/EPPO, 1997). In Asia S. dorsalis is of considerable economic importance as a pest of the sixteen crops listed in Table 1.

Due to polyphagous behavior and very large host range, S. dorsalis has the potential to cause significant economic damage to a diverse variety of commodities if it were to establish widely in the U.S. S. dorsalis has been reported as a serious pest on cotton in Ivory Coast, India, and Pakistan, on citrus in Japan and Taiwan, on peanuts in India, on peppers and chilies in India, mangos in Taiwan, litchi (lychee) in China, on roses in India and Taiwan, Hevea brasiliensis in Malaysia, and lotus in Taiwan, (Meissner et al. 2005), strawberries in Queensland and Australia, tea in Taiwan, soybeans in Indonesia, (Hodges et al. 2005), pepper and groundnuts in India, grapevine (although S. dorsalis may not breed on grapevine) and tea in Japan, (GPDD 2006), and chilli peppers in Sri Lanka (Schall 1995). S. dorsalis has also been reported to cause damage in onions, tomatoes, tamarind, cashews, and castor beans (Hodges et al. 2005). The majority of the above listed commodities occur in the U.S. and in fact 34 major commodity hosts exist in areas climatically suitable for establishment (Meissner et al. 2005). According to a preliminary analysis by Garrett (2004), if S. dorsalis caused only 5% loss to these crops it would result in $3 billion dollars in losses in the USA, but if crop loss were to reach 10%, then the total economic loss could reach close to $6 billion dollars.

STATUS OF Scirtothrips dorsalis IN THE GREATER CARIBBEAN REGION

Barbados. A team from the Barbados Ministry of Agriculture and Rural Development and USDA-APHIS surveyed Barbados for S. dorsalis in 2005 and 2006 (Taylor et al. 2007). They found S. dorsalis distributed in most of the Parishes, but that in general the population densities of S. dorsalis in Barbados were lower than those observed previously on other Caribbean islands, perhaps indicating that it may have been introduced more recently. Hot peppers (Capsicum chinensis) were widely affected throughout the island, although severe damage was not observed. Adults and larvae were found on sweet pepper (Capsicum annuum), beans (Phaseolus vulgaris), carrots (Daucus carota sativus L.), eggplant (Solanum melongena L.), and on sea island cotton (Gossypium barbadense L.). On the latter, population densities of the pest reached very high levels (100 – 200 larvae and adults per terminal) and caused bronzing of the upper leaf surface, stunting, slight curling, and leaf drop.

Florida. In Florida the chilli thrips, S. dorsalis, was first detected in 1991 in a retail center in Okeechobee County, and in 1994 in another retail center in Highlands County. Both of these infestations apparently failed to persist (Silagyi and Dixon, 2006). No additional detections were reported between 1994 and 2005. In 2004, the Florida Cooperative Agricultural Pest Survey

(CAPS) program conducted a survey for S. dorsalis in Broward and Miami-Dade Counties in South Florida. The survey targeted primarily ethnic markets and their environs with some commercial pepper and cucurbit fields included. Specific commodity surveys of tomato (Lycopersicum esculentum) and pepper (Capsicum spp.) were also conducted in 2004 and early 2005, but no S. dorsalis was found (Silagyi and Dixon, 2006).

However, during the summer of 2005, a number of home owners observed damage symptoms on roses (Rosa sp.) and especially on the cultivar 'Knockout'. Geoff Coolidge, a fancier of roses, published an article in the September 2005 issue of 'The Rose Petal', the newsletter of the Greater Palm Beach Rose Society, in which he stated: "It seems a new species of thrips has entered our Florida gardens and its damage has become very apparent over the summer months. Severe damage from these "new thrips" has been recently detected on roses from Miami to Orlando" (Coolidge, 2005). The thrips, collected on October 1 and 2, 2005 in retail garden centers in Highlands and Okeechobee Counties were identified as S. dorsalis (Hodges et al. 2005).

The Cooperative Agricultural Pest Survey (CAPS), APHIS, the Florida Department of Agriculture and Consumer Services and the University of Florida immediately undertook surveys. By the end of 2005, S. dorsalis had been detected 77 times in 60 retail garden centers in 16 counties (Map 1) (NPAG, 2006: Silagyi and Dixon, 2006). Most of the infested plants in retail centers were 'knockout' rose, and the remainder were pepper seedlings. Next, the CAPS team designed an environs survey based on 5-mile radii around positive nursery detections in Lake, Orange and Seminole Counties all in central Florida with the highest number of positive samples. The objectives of the survey were to establish the extent of S. dorsalis populations had become established near infested garden centers and to identify additional host plants in Florida. The survey was conducted June 5 - 9, 2006. Within each 5-mile radius, residential and commercial areas with ornamental rose plantings and/or gardens containing peppers were inspected visually. Additional ornamental plants in close proximity to roses or peppers were also inspected.

Of the 37 samples submitted for identification, 27 samples taken from 25 properties were identified positive for S. dorsalis, which indicated that the pest was established on 45% of the surveyed properties on the following taxa: Capsicum sp., Duranta erecta, Pittosporum tobira, Rhaphiolepsis umbellate, Rhododendron sp., Ricinus communis, Rosa sp. and Viburnum suspensum. By September 2006, S. dorsalis had been positively identified 186 times in 24 of Florida's 67 counties in a multitude of settings such as retail garden centers, residences, businesses, parks and along roadside. By November, 2007, S. dorsalis had been found in 30 counties (Bostic, 2007). S. dorsalis was a significant problem in strawberry production in 2006, but not subsequently (Andrew Derksen, personal communication). Many strawberry growers release predatory mites on strawberry against phytophagous mites, but it is not known if these mites prey on S. dorsalis.

Reproductive host plants of S. dorsalis in Florida. Plants in Florida on which S. dorsalis has been found to reproduce (Osborne, 2008) are as follows: Antirrhinum majus L. (Liberty Classic White Snapdragon), Arachis hypogaea L. (peanut or groundnut, grown in greenhouse), Begonia sp. (Begonia), Breynia nivosa (W. Bull) Small (snow bush, snow-on-the-mountain), Capsicum

annum L. (pepper), Celosia argentea L. (celosia – red fox), Coreopsis sp. (tickseed), Cucumis sativus L.(cucumber), Cuphea sp.(waxweed, tarweed), Duranta erecta L. (golden dewdrop, pigeonberry, skyflower), Euphorbia pulcherrima Willd. (poinsettia), Eustoma grandiflorum (Raf.)Shinn. (Florida Blue Lisianthus), Ficus elastica 'Burgundy' Roxb. ex Hornem (Burgundy Rubber Tree), Fragaria x ananassa (strawberry), Gaura lindheimeri Engelm. & Gray (Lindheimer's beeblossom), Gerbera jamesonii H. Bolus ex Hook. f. (Gerber daisy), Glandularia x hybrida (Grönland & Rümpler) Neson & Pruski (Verbena), Gossypium hirsutum L. (cotton grown in greenhouse), Hedera helix L. (English ivy), Impatiens walleriana Hook. f. (Super Elfin White), Lagerstroemia indica L. (Crape myrtle), Ligustrum sp. (Ligustrum), Ocimum basilicum L. (Sweet Basil), Pelargonium x hortorum Bailey (Geranium), Pentas lanceolata (Forssk.) Deflers (Graffiti White), Petunia x hybrida (Petunia Easy Wave Red), Pittosporum tobira (Thunb.) W. T. Aiton (Variegated Pittosporum), Plectranthus scutellarioides (L.) R. (Coleus), Plumbago auriculata Lam. (Cape leadwort, plumbago, jamin azul), Ricinus communis L. (Castor Bean), Rhaphiolepis umbellate (Thunb.) Makino (Yeddo Hawthorn), Richardia brasiliensis Gomes (Brazil Pusley, tropical Mexican clover, in a greenhouse), Rhododendron sp., Rosa sp. (rose), Salvia farinacea Benth. (Victoria blue), Shefflera arbicola (Hayata) Merr. (umbrella tree), Tagetes patula L. (marigold), L. Tradescatia zebrina hort. ex Bosse (wandering jew), Vaccinium corymbosum L. (highbush blueberry), Viburnum odoratissimum var. awabuki (K. Koch) Zabel (sweet viburnum), Viburnum suspensum Lindl. (Viburnum), Viola x wittrockiana Gams (Wittrock's violet), Vitis vinifera L. (grapevine), and Zinnia elegans Jacq. (Zinnia Profusion White).

Regulatory response in Florida. The regulatory response of the Florida Department of Agriculture and Consumer Services is that (1) S. dorsalis is a serious plant pest of quarantine significance, and (2) when detected in retail garden centers or commercial nurseries, all infested nursery stock is quarantined until the pest has been eliminated (Clark, 2006).

S. dorsalis continues to significantly damage landscape ornamental plants, most commonly roses, ligustrum, lisianthus, pittosporum, various herbs including sweet basil, begonia, and Indian hawthorn. The pest is easily killed with certain insecticides, which provide temporary control (Seal et al. 2005; Seal et al. 2006a). In many instances, landscape care companies apply insecticidal sprays every two or three weeks, or whenever the plants have new flushes of growth. Thus far in Florida the pest has not posed a problem in commercial vegetable and tropical fruit production. As a result of our collaboration with the Ministry of Agriculture, Forestry and Fisheries of Saint Vincent and the Grenadines, which had begun in January 2004, we had developed high quality information on within-plant, within-field distribution, sampling, and chemical control of S. dorsalis (Seal et al., 2006a and 2006b). Thus within less than two months after the initial detection of S. dorsalis in Florida, we had published provisional management guidelines for S. dorsalis outbreaks in Florida (Seal et al., 2005). Also a continuing series of training workshops for County extension personnel and horticultural industry representatives were organized and implemented under the leadership of Dr. Amanda C. Hodges, University of Florida Extension Scientist, and Professor Lance S. Osborne, Mid-Florida Research and Education Center.

Threat of further spread within the USA. The potential distribution of S. dorsalis in the continental USA was assessed by Nietschke et al. (2008) using the NAPPFAST weather-based

mapping tool. They projected that S. dorsalis has the potential to establish and become a serious economic problem on the southern and western coastal plains of the USA.

US Chilli Thrips Interagency Working Group. In 2006 the "Chilli Thrips (S. dorsalis) Interagency Working Group" was formed. It includes National Plant Board representatives and USDA-APHIS PPQ staff from the southern states, Arizona and California and is chaired by Mr. Bill Grefenstette of APHIS PPQ. This Working Group has been charged with "designing and implementing necessary operational plans to prevent or minimize Chilli Thrips effects on the various industries. The working Group will be taking into consideration the following issues: 1) Industry concerns and needs; 2) Economic implications of the pest; 3) Technical recommendations; 4) practical options to limit the spread and impact of Chilli Thrips; and 5) Assist in the registration of needed insecticides" (National Plant Board, 2008).

Jamaica. In 1995 S. dorsalis was found on bitter melon, Momordica charantia, taken from a traveler from Jamaica upon arrival at the international airport in Atlanta, Georgia. Dr Lisa Myers, Chief Plant Protection Officer, Plant Protection Unit, Ministry of Agriculture and Lands (email to Ms. Dionne Clark-Harris, 22 May 2008) suggested this was the basis for the assertion in a pest alert by Florida Department of Agriculture and Consumer Service (Hodges et al., 2005) that S. dorsalis was established in Jamaica. However in 2007 S. dorsalis was found on hot pepper in one commercial field at Ebony Park by Ms. Juliet Goldsmith, Plant Protection Officer, Ministry of Agriculture, Jamaica, but it could not be found in a subsequent survey (Myers, ibid). Nevertheless On March 2, 2008 infested sugar apple (Annona squamosa L.) fruit, which had been produced in Jamaica, was taken from a traveler crossing on land from British Columbia, Canada to Blaine, Washington (PestID Database, March 2, 2008). Taken together, this very limited information suggests that S. dorsalis may be present in Jamaica but in very sparse populations.

Puerto Rico. In early 2006, S. dorsalis was confirmed from samples collected in Jardin La Ceiba, Puerto Rico (NPAG, 2006). The initial detection was made on roses, which may have originated from an infestation in a nearby retail garden center. Now, as determined by the Cooperative Agricultural Pest Survey, the pest is widespread throughout the island, and it is most troublesome on mango and somewhat damaging on pepper, cucurbits and watermelon (J. Moreno and A Ramirez, personal communication, 2008).

St. Lucia. A team from the St. Lucia Ministry of Agriculture, Forestry and Fisheries, University of Florida and USDA-APHIS (Ciomperlik and Seal, 2004) surveyed 4 of the 8 Districts of St. Lucia in January 2004. These were Districts 3, 4, 5 and 7. S. dorsalis was found in all of them. The highest total number of S. dorsalis adults (58) was collected in District 5 followed by District 4. The crops and corresponding percentages of leaf samples positive for S. dorsalis were as follows: pepper, >50%; cucumber, 46%; and eggplant, 40%. In addition, S. dorsalis was found on Amaranthus sp., zucchini and on an ornamental crop. During this single visit, S. dorsalis was not found on canteloupe, summer squash, tomato, or watermelon.

St. Vincent and the Grenadines. In 2003, Skarlinsky (2003) discovered S. dorsalis in pepper fields on St. Vincent. Therefore, a team from the St. Vincent and the Grenadines Ministry of Agriculture and Fisheries, University of Florida and USDA-APHIS (Ciomperlik and Seal, 2004)

surveyed the 8 Districts of St. Vincent in January 2004, and found S. dorsalis in 7 Districts with the largest numbers collected in Districts 1 and 4E. The numbers of S. dorsalis collected in the Districts in descending order in other districts were 4E, 1, 7, 5, 8, 6, 3 and 4W. The percentages of infested samples from various crops were as follows: pepper, >60%; okra, 60%; pumpkin, 28.5%; watermelon, 28.5%; eggplant, 20% and tomato,17%. However S. dorsalis was not found on Amaranthus sp., cantaloupe or cucumber. In an experimental planting of pepper cultivars, the percentages of infested samples were as follows: bell pepper, 47%; 'Habanero', 37%; Scotch Bonnet', 27%; 'West Indian Red', 18%; and 'Santa Fe', 11%.

Additional thrips species identified from Saint Vincent included Thrips palmi Karny, Chaetanaphothrips sp. Frankliniella spp. and others. The numbers of other thrips greatly exceeded S. dorsalis in all crops samples. S. dorsalis accounted for only 23% of the total thrips collected on pepper.

Suriname. The pest was detected in 2004 on bitter melon/gourd (Momordica charantia) (EPPO, 2004). In December 2005 field surveys conducted by Maitrie Jagroep, Suriname Ministry of Agriculture, Animal Husbandry and Fisheries and M. A. Ciomperlik, USDA-APHIS showed that S. dorsalis was established on hot pepper and 'Cleopatra" citrus rootstock in the three surveyed coastal regions of Kwatta, Commewijne and Saramacca (GPDD, 2007). The pest caused leaf curl on 'Cleopatra' citrus root stock seedlings, but not on grafted lemon or orange varieties. Lab lab (Dolichos lablab) and bitter melon/gourd were both infested with the pest but much less severely than hot pepper.

Texas. In November 2005, M. A. Ciomperlik found S. dorsalis on pepper (Capsicum sp.) seedlings in retail outlets in 3 counties of the Rio Grande Valley of south Texas (NPAG, 2006), but no established populations could be found in the field. Then in November 2007, S. dorsalis was found established on roses in the landscape in Houston, Harris County, Texas (Ludwig, 2008). In addition, S. dorsalis specimens have been found on various ornamental and vegetable plants in retail outlets in northeastern Texas (Ludwig, 2008). The pest is viewed as a serious threat to the production of cotton, peanuts, grapes, tomatoes and hot peppers in Texas.

Trinidad and Tobago. Shripat and Parkinson (2005) reported that "a detection survey was conducted in May 2004 in Trinidad. S. dorsalis was found in 21 (9%) of the 240 farms surveyed in 6 of the 8 counties in Trinidad. S. dorsalis was found in Solanum melongena, Capsicum spp., Abelmoschus esculentus and cucurbits. St. George West County had the highest incidence of S. dorsalis. In this county the pest was observed at 8 (27%) of 30 farms sampled in 6 of 15 areas surveyed. In Caroni it was observed at 4 (13%) of 30 farms; in St. Patrick East 3 (10%) of 30 farms; in Nariva/Mayaro at 3 (10%) of 30 farms; St. Andrew/St. David at 2 (7%) of 30 farms and in St. George East and only 1 (3%) of 30 farms surveyed. The pest was not found in samples collected from St. Patrick West and Victoria.

S. dorsalis was found mainly on the leaves of crops and to a lesser extent in flowers. The predominant thrips species on these vegetable crops was Thrips palmi. Followed by Frankliniella insularis and then S. dorsalis.

According Fortune (Dr. Mario Fortune, personal communication), S. dorsalis is not considered to be a significant pest in Trinidad.

Venezuela. Since 2000, S. dorsalis has been causing damage to grapevine (Vitis vinifera L.) in western Venezuela (CABI, 2005; Collins et al., 2006).

Countries in which S. dorsalis is believed to be absent. S. dorsalis has not been found in the French West Indies (J. Iotti personal communication, 2008), Dominican Republic (Serra, 2008), nor in Costa Rica (Seal and Klassen, unpublished). In 1995 S. dorsalis was found on flowers in the baggage of a passenger from El Salvador to the USA, but the authors are not aware of evidence to suggest that the pest is established in El Salvador or in any Central American country, or in Cuba.

ACTIONS NEEDED TO CONTAIN AND MANAGE THE PROBLEM

[1] Appropriate regulatory policies and programs throughout the Greater Caribbean Region need to be maintained and in some instances developed.

[2] Systematic surveys are needed to determine: (1) if new host species exist (2) the limits of geographic spread, and (3) whether natural controls are being assembled, e.g., what is preventing S. dorsalis from reaching outbreak levels in Jamaica and Trinidad?

[3] The most urgent need in Florida is to develop a durable pest management system for use on ornamental plantings that does not require frequent interventions with insecticides. Readily available predatory mites and thrips should be evaluated for use in inundative releases. Additional natural enemies should be brought from south Asia. Also, evaluations of entomopathogenic fungi and other entomopathogens, as well as innovations in formations of these agents should be accelerated.

[4] Presumably for the short term, the insecticides used in rotational schemes against insect pests of tropical fruit and vegetable crops will protect these crops from S. dorsalis. Nevertheless, both vegetable crops and tropical fruits should be scouted for indications that S. dorsalis is becoming adapted to measures used in the commercial production of these crops.

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Table 1. Crops in Asia on which Scirtothrips dorsalis is a pest of considerable economic importance

Crop	Country; Reference
Cashew, Anacardium occidentale L.	India; Ananthakrishnan (1984)
Castor bean , Ricinus communis L.	India; Ananthakrishnan (1984)
Chilli pepper, Capsicum annum var. annum L.	India; Ananthakrishnan (1984)
Citrus, especially C. unshiu Marcov (satsuma mandarin)	Japan, Taiwan; Chiu et al. (1991), Chu et al. (2006); Tatara and Furuhushi (1992), Tschuchiya et al. (1995)
Cotton, Gossypium spp.),	India, Cote d'Ivoire; Bournier (1999)
Grapevine, Vitis vinifera L.	India, Japan; Thirumurthi et al. (1972)
Hydrangea spp.	CABI/EPPO (1997)
Kiwi, Actinidia chinensis Planchon	CABI/EPPO (1997)
Mango, Mangifera indica L.	India; Ananthakrishnan (1984)
Onion, Allium cepa L.	India; Ananthakrishnan (1984)
Peanut, Arachis hypogaea L.	India; Mound and Palmer 1981).
Pepper, sweet (Capsicum annum var. annum L.) and hot (C. chinense Jacq.)	India, Taiwan, Thailand; CABI/EPPO (1997), Ananthakrishnan (1984)
Persimmon, Diospyros kaki Thunb.	Japan; CABI/EPPO (1997)
Rose, Rosa spp.	India; Ananthakrishnan (1984)
Rubber tree, Hevea brasiliensis (Willd. ex A. Juss.) Müll. Arg.	Taiwan; (CABI/EPPO, 1997)
Sacred lotus, Nelumbo nucifera Gaertn.	India; CABI/EPPO (1997)
Soybean, Glycine max (L.) Merr.	Indonesia; Miyazaki et al. (1984)
Strawberry, Fragaria ananassa X F. virginiana Duchesne	Queensland, Australia; Mound and Palmer (1981)
Tamarind, Tamarindus indica L.	India; Ananthakrishnan (1984)
Tea, Camellia sinensis (L.) Kuntze	Taiwan, Japan; Okada and Kudo (1982)
Tobacco, Nicotiana tabacum	India; Ananthakrishnan (1984)
Tomato, Lycopersicon esculentum Mill.	India; Ananthakrishnan (1984)
Various ornamentals	India; Ananthakrishnan (1984) , Japan