Thrips setosus (Thysanoptera: Thripidae), the Japanese flower thrips, in cultivation of *Hydrangea* in the Netherlands

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Thrips setosus **Moulton, the Japanese flower thrips, has been found for the first time in the Netherlands. On September 30 2014, 22 females and 5 larvae of this species were detected on *Hydrangea* in a nursery at Kudelstaart. Until then, *T. setosus* had only been known from Japan and South Korea, where it is a polyphagous minor pest and with no known association with *Hydrangea*. Remarkably, interceptions in the international trade of plant products of this opportunistic species are very scarce, and this thrips has not been recorded as an invasive species. A survey carried out showed its presence in several *Hydrangea* nurseries in the Netherlands. However, the origin of the populations and the year of introduction into the country could not be established. Based on a short risk analysis it has been decided not to focus on elimination of the species, but to inform national and international organizations involved in plant protection about its occurrence. Details about its detection and identification, and the results of the survey, are presented.**

Introduction

Thrips (Thysanoptera) are known as plant pests worldwide, especially in ornamentals and vegetables. Some species (e.g. *Frankliniella occidentalis* (Pergande), *Thrips simplex* (Morison), *T. tabaci* Lindeman) have spread with infested plant material all over the world. These thrips are opportunistic and highly invasive species (Mound & Teulon 1995, Vierbergen 1995). However, other similar species have not shown similar geographic spread thus far. One of these, *T. setosus* Moulton, has recently been detected in the Netherlands and in this paper we describe details about its detection and how it was identified. Additionally results of some follow up measures by the Netherlands Food and Consumer Product Authority (NVWA) are given.

Detection and identification

On September 30, 2014, an inspector of the Netherlands Inspection Service for Horticulture (Naktuinbouw) detected a serious thrips infestation in *Hydrangea* culture in Kudelstaart. He observed the typical thrips feeding damage (silvery spots, with dark punctures) on leaves of plants growing both inside and outside of the glasshouse and established the presence of a dark coloured thrips (figures 1-4). These specimens differed in colouration and shape from the commonly occurring thrips species in Dutch glasshouses, and consequently the inspector sampled some infested plant material in a sealed plastic bag together with twelve thrips females in a tube with ethanol. For diagnostic purposes he sent this material together with site information to the National Reference Centre of the NVWA.

On the infested plant material, ten thrips females and five thrips larvae were detected. Identification of the 22 females from the tube and the plant material was performed by morphological examination after preparation of microscope slide-mounts (mountants: Hoyer's and Canada Balsam, figures 5-8) using various identification keys. With the dichotomous table European species of *Thrips* in Zur Strassen (2003) the specimens keyed out to *T. fulvipes* Bagnall, a species known to occur in shadowed woodland on *Mercurialis perennis* throughout Europe. That species is larger with a body length of the female 1520-1780 µm (Zur Strassen 2003) instead of 1250-1330 µm for our specimens) and has S1 setae on tergite IX 120-150 µm (Zur Strassen 2003) instead of 76-83 µm. Therefore, the possibility that the specimens belonged to a known European species was excluded. In a key for Asian species of *Thrips* (Palmer 1992), the specimens keyed out to *T. setosus*, a species well described by Umeya *et al.* (1988) and Mound (2005). A reference microscope slide-mount from a small series collected in Japan (SMF T9590), was used for comparison. This slide originates from the Thysanoptera collection of the Senckenberg Museum in Frankfurt am Main, Germany. It contains a female of *T. setosus*, sampled by Dr. R. Zur Strassen during the XVI International Congress of Entomology in Kyoto, 3-9 August 1980. The second stage larvae present on the sampled plant material in Kudelstaart were also identified as *T. setosus* by using the key and description in Miyazaki & Kudo (1986). Adults and larvae could be identified

1. Upper side leaf damage of glasshouse *Hydrangea* caused by *Thrips setosus*. Photo: Wietse den Hartog, NVWA
1. Door *Thrips setosus* veroorzaakte schade aan de bovenzijde van het blad van kasgeteelde *Hydrangea*.

2. Underside of a leaf of *Hydrangea* with silvery sucking damage caused by *Thrips setosus*. Photo: Wietse den Hartog, NVWA
2. Door *Thrips setosus* veroorzaakte zilverkleurige zuigschade aan de onderzijde van een blad van *Hydrangea*.

according to gender (Vierbergen *et al.* 2010). In total 334 female adults, 7 male adults, 34 female larvae and 14 male larvae were found (table 1). This results in an adult female sex ratio of 1:0.02 and a larval equivalent of 1:0.41. The ratio of the adults is based on field collection. Both a better detection on plant parts of dark adult females (figure 2) than of the yellow adult males (figure 6) as well as the usually longer life time of thrips females than males can explain the difference between the adult and larval female sex ratio. From the ratio found in larvae the kind of reproduction could be haploid facultative arrhenotoky, as is found in many thrips species with a female ratio of 1:0.25 (Kumm 2002). Because a female ratio of 1:0.7 is assumed for *T. setosus* (Murai 2001a) further investigation is necessary to establish the kind of reproduction.

Host plant range and survey

Thrips setosus is primarily a leaf feeding thrips (Murai 2001a). The English name 'Japanese flower thrips' (Mound 2005) suggests *T. setosus* feeds in flowers, but it does not feed on pollen (Murai 2001a) and for this reason it cannot be regarded as a true flower thrips. Leaf-feeding thrips as a rule move much less from plant to plant than pollen feeding species. Because of this we assume records mentioned in table 2 refer, in significant part, to true host plants on which reproduction and development takes place. However, *Hydrangea* (Hydrangeaceae) has not previously been recorded as a host plant for this species. On *Hydrangea*, *T. setosus* feeds on the leaves (figures 2 and 3) as well as on the sterile flowers (figure 4). These sterile flowers do not fall down after the flowering period, but persist in autumn even after leaf fall.

Because of the species' polyphagous nature and its preference for feeding on leaves, special attention was paid during the survey to its occurrence on other plant species in the neighbourhood of the inspected nurseries, including naturally occurring herbaceous plants. In Kudelstaart, *T. setosus* could be detected in the glasshouse as well as in the field (table 1). At the border of the production site, some common herbaceous plants were also found to be infested. On the *Hydrangea*, no other Thysanoptera species were found, but on one of the herbs, *Lamium purpureum,* the common species *Thrips tabaci* Lindeman, the onion thrips, was collected.

Geographical distribution

In Japan, *T. setosus* is widely distributed, and it is locally abundant on the northern island Hokkaido. This abundance is probably due to its reproductive diapause enabling it to survive relatively severe winters (Nakao 1998). Although less thoroughly investigated in South Korea, it can be assumed the species is widespread on the peninsula as it has been recorded from Samcheok and Haeundae in the east (Woo 1974) and from Suwon and Muan in the west (Woo & Choo 1986). A recent record from a tropical climate zone, Indonesia (Sumatra, Johari 2015), has not been confirmed and should be regarded as 'doubtful'. Additionally *T. palmi, T. coloratus, Ceratothripoides brunneus* and *T. hawaiiensis* in Johari's paper have not been confirmed either. Because of its climatic range we assume that *T. setosus* will likely survive Dutch winters, even in the northern parts of the country.

3. Adult female and larva I of *Thrips setosus* on underside of a leaf of *Hydrangea*. Photo: Rens van den Biggelaar, NVWA
3. Vrouwtje en larve I van *Thrips setosus* aan onderzijde van een blad van *Hydrangea*.

4. Adult females of *Thrips setosus* on a sterile *Hydrangea* flower. Photo: Wietse den Hartog, NVWA
4. Vrouwtjes van *Thrips setosus* op een steriele *Hydrangea*-bloem.

Trace and tracking

Despite its wide geographical distribution in Japan and its wide host range, interceptions on import plant material originating from Japan (or Korea) are very scarce. In the 1970s, an interception was reported on cut flowers of *Dianthus* from Japan in the USA (Anonymous 1979). In the beginning of the 1980s, another interception was reported from the USA: '*Rosa* (flower), import Brasil (?) Japan' (Anonymous 1982). Little is known, therefore, about the pathways. Potential pathways could be plants for planting and stems of host plants (e.g. cuttings, cut flowers, rooted plants, etc.). The nursery in Kudelstaart did not import its plants directly. Its suppliers were successively inspected by the NVWA and in four locations the presence of *T. setosus* could be established (table 1). In the Netherlands the last import of *Hydrangea* from Japan dated from 2011, complicating tracing of the thrips in this culture.

Plant damage and pest management

Thrips setosus is a typical leaf feeder (Murai 2001a). As well as causing direct feeding damage, it is also able to transmit tomato spotted wilt virus (TSWV) within field crops, as well as between weeds and cultivated field crops. Kobatake (1984) describes heavy infections by TSWV in Japan in a tomato field in July 1977 and 1978. In these cases, *T. setosus* had transmitted the virus from the weeds *Sonchus oleraceus* and *Crepis japonica* to tomato and within the tomato crop. Control of the thrips decreased virus incidence. Worldwide, *T. setosus* is one of the ten species of thrips known to be able to transmit TSWV (EFSA 2012). For this reason, in the Netherlands special attention was paid to checking for the presence of TSWV in *Hydrangea*. No obvious symptoms were observed, but some plants from Kudelstaart with dubious symptoms were tested for TSWV by DAS-ELISA and RT-PCRs with generic primers for known tospoviruses at the National Reference Centre of the NVWA. All results were negative for TSWV. Some symptoms, however, were caused by hydrangea ringspot virus, which commonly occurs in *Hydrangea*. This virus was detected with DAS-ELISA. Thysanoptera, however, are not known to vector this virus.

Although *T. setosus* is widely distributed in Japan, it is regarded as a minor pest (Murai 2001b, Mochizuki 2014). It is highly susceptible to a large number of insecticides, which allows sufficient control (Umeya *et al.* 1988). In the Netherlands, such control regimes may be necessary for controlling the direct damage caused by this thrips species as well as the potential virus it could transmit. The spectrum of insecticides currently allowed could be sufficient to control this thrips. Which natural enemies would be effective in an Integrated Pest Management setting, however, still has to be investigated.

Risk assessment

A preliminary risk analysis has been completed for *T. setosus* in order to investigate the validity of a survey, to investigate the level of spread, and to assess whether elimination is still feasible and possible (Anonymous 2014). The results of the survey in 2014 show that the spread in the Netherlands on commonly cultivated *Hydrangea* had already taken place for at least one year or more. In *Hydrangea* nurseries in the Netherlands high numbers of the thrips were observed, with actual development

Table 1. Sampling results of *Thrips setosus* at the nursery in Kudelstaart and its suppliers. Adults and larvae are specified by gender. * Additionally 1 larva II♀ *Thrips tabaci* Lindeman.
Tabel 1. Verzamelresultaten van *Thrips setosus* bij de kwekerij te Kudelstaart en bij haar leveranciers. Adulten en larven zijn per sekse weergegeven. * Tevens 1 larve II♀ *Thrips tabaci* Lindeman.

Date / datum	**location** / locatie	**plant species** / plantensoort	**material sampled** / verzamelresultaten
30-ix-2014	Kudelstaart	*Hydrangea* (glasshouse)	22♀♀, 3 larvae II$^{2♀♀,1♂}$ and 2 larvae I$^{2♀♀}$
10-x-2014	Kudelstaart	*Hydrangea* (glasshouse)	35♀♀, 1♂, 5 larvae II$^{5♀♀}$ and 1 larva I$^{♀}$
10-x-2014	Kudelstaart	*Hydrangea* (field)	103♀♀, 3♂♂, 1 larva II$^{♀}$ and 6 larvae I$^{5♀♀,1♂}$
10-x-2014	Kudelstaart	*Heracleum sphondylium* (field)	11♀♀ and 4 larvae II$^{2♀♀,2♂♂}$
10-x-2014	Kudelstaart	*Lamium purpureum* (field)*	2♀♀ and 3 larvae II$^{2♀}$♀♀,$^{1♂}$
10-x-2014	Kudelstaart	*Urtica dioica* (field)	4♀♀
10-x-2014	Kudelstaart	*Urtica dioica* (field)	4♀♀
17-x-2014	Boskoop	*Hydrangea* (glasshouse)	20♀♀ and 5 larvae II$^{1♀,4♂♂}$
17-x-2014	Boskoop	*Hydrangea* (field)	10♀♀, 1♂, 1 larva II$^{♂}$ and 1 larva I$^{♀}$
17-x-2014	De Kwakel	*Hydrangea* (glasshouse)	79♀♀, 2♂♂, 3 larvae II$^{2♀♀,1♂}$ and 1 larva I$^{♂}$
17-x-2014	De Kwakel	*Hydrangea* (field)	11♀♀
20-x-2014	Reeuwijk	*Hydrangea* (glasshouse)	13♀♀
20-x-2014	Reeuwijk	*Hydrangea* (field)	5♀♀ and 5 larvae II$^{3♀♀,2♂♂}$
24-xi-2014	Reeuwijk	*Hydrangea* (glasshouse)	15♀♀, 6 larvae II$^{6♀♀}$ and 1 larva I$^{♀}$

Table 2. Plants on which *Thrips setosus* has been found. [Names given in bold refer to plants occurring in the open in the Netherlands]. Sources: (1) Miyazaki & Kudo (1988); (2) Mizobuchi *et al.* (1991).
Tabel 2. Planten waarop *Thrips setosus* gevonden is. [Namen in vet betreffen planten die in Nederland in de open lucht voorkomen]. Bronnen: (1) Miyazaki & Kudo (1988); (2) Mizobuchi *et al.* (1991).

Asteraceae	*Chrysanthemum cinerariifolium* (1), ***Chrysanthemum morifolium*** (1), ***Cirsium*** *japonicum* (2), ***Dahlia*** *sp.* (1), *Kalimeris pinnatifida* (1), *Kalimeris yomena* (1), ***Lactuca sativa*** (1), ***Sonchus oleraceus*** (1), *Youngia japonica* (1)
Balsaminaceae	***Impatiens balsamina*** (1)
Brassicaceae	***Brassica oleracea*** (2)
Caprifoliaceae	*Abelia spathulata* (2)
Convallariaceae	*Ophiopogon jaburan* (2)
Cucurbitaceae	*Citrullus battich* (1), *Cucumis melo* (1), *Cucumis sativus* (1), *Cucurbita moschata* (1), *Momordica charantia* (2)
Dioscoreaceae	*Dioscorea japonica* (2)
Ebenaceae	*Diospyros kaki* (1)
Labiatae	***Lamium amplexicaule*** (2), ***Mentha arvensis*** (1)
Fabaceae	*Dumasia truncate* (2), *Glycine max* (1), ***Phaseolus vulgaris*** (1), ***Pisum sativum*** (1), *Pueraria lobata* (2), ***Trifolium repens*** (1), ***Vicia sativa*** (2)
Iridaceae	***Iris*** sp. (2)
Moraceae	***Ficus carica*** (1)
Onagraceae	***Oenothera*** sp. (2)
Pedaliaceae	*Sesamum indicum* (1)
Polygonaceae	***Polygonum*** sp. (2)
Rosaceae	***Fragaria ananassa*** (1)
Rutaceae	*Citrus* sp. (1)
Simaroubaceae	*Ailanthus altissima* (2)
Solanaceae	*Capsicum annuum* (1), ***Datura stramonium*** (1), ***Lycopersicum esculentum*** (1), *Nicotiana tabacum* (1), *Solanum melongena* (1), ***Solanum tuberosum*** (2)
Theaceae	*Camellia sinensis* (1)
Vitaceae	***Vitis vinifera*** (1)

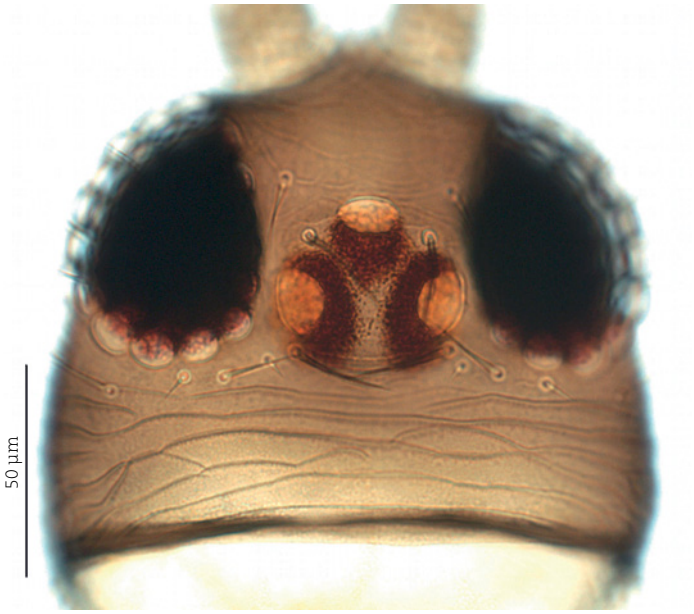
on infested plants. In the field around one nursery some common herbs were also infested, showing that spread had already taken place beyond the *Hydrangea* cultivation area and into the open. For these reasons, and because of the polyphagous nature of the thrips, and because the origin of the population or populations could not be traced, it was decided that elimination measures would most likely be unsuccessful. In view of the risk of *T. setosus* invading other countries in Europe, and in order to investigate the possible presence and spread in those countries, the European and Mediterranean Plant Protection Organization has added *T. setosus* to their 'Alert List' (EPPO 2014).

Future prospects

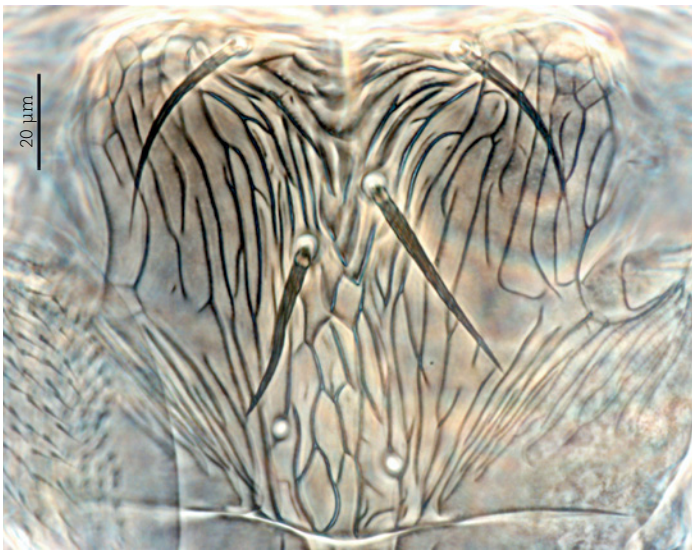
Hydrangea was not previously reported to be a host plant of the species and it seems very likely that *T. setosus* will also be able to invade new crop cultures in the near future. Additionally, the thrips can possibly play a role as a vector of TSWV in the field. In the Netherlands, TSWV is rarely observed in field crops and

5. Adult female of *Thrips setosus* in a microscopic slide. Photo: Bert Vierbergen, NVWA
5. Vrouwtje van *Thrips setosus* in microscopisch preparaat.

6. Adult male of *Thrips setosus* on a microscopic slide. Photo: Bert Vierbergen, NVWA
6. Mannetje van *Thrips setosus* in microscopisch preparaat.



7. Head (dorsal) of adult female of *Thrips setosus*. Photo: Bert Vierbergen, NVWA
7. Bovenzijde kop van vrouwtje van *Thrips setosus*.



8. Metanotum of adult female of *Thrips setosus* (phase contrast). Photo: Bert Vierbergen, NVWA
8. Metanotum van vrouwtje van *Thrips setosus* (fase-contrast).

the overwintering thrips populations do not show any transmission in these crops. Its occurrence on *Hydrangea* outdoors proves that reproduction and development of this thrips species in the Netherlands can occur during summer. Although overwintering by *T. setosus* under Dutch climatic conditions is likely, this has yet to be confirmed. Time will show us if *T. setosus* can establish indoors as well as outdoors, and whether due to its economic and ecological significance control programs must be developed.

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References

Anonymous 1979. List of intercepted plant pests (pests recorded from July 1, 1973 trough september 30, 1977). Animal and Plant Health Inspection Service 82-5. United States Department of Agriculture.

Anonymous 1982. List of intercepted plant pests. Fiscal years 1980 and 1981. Animal and Plant Health Inspection Service. Plant Protection and Quarantine. United States Department of Agriculture.

Anonymous 2014. Quick scan (QS. Ent.2014.11 – dated 17 October 2014). National Plant Protection Organization, the Netherlands. Available at: www.nvwa.nl/txmpub/files/?p_file_id=2207523. [Consulted 9 March 2015]

EFSA 2012. Scientific opinion on the pest categorisation of the tospoviruses1. EFSA Journal 10: 2772. Available at: www.efsa.europa.eu/en/efsajournal/doc/2772.pdf. [Consulted 6 March 2015]

EPPO 2014. *Thrips setosus* (Thysanoptera: Thripidae). EPPO RS 2014/181. Available at: www.eppo.int/QUARANTINE/Alert_List/insects/thrips_setosus.htm. [Consulted 9 March 2015]

Johari, A 2015. The diversity species of thrips sp. (Thysanoptera: Thripidae) in chili plantation (*Capsicum annuum* L.) in the region of Jambi. Indian Journal of Science Research and Technology 3: 65-70.

Kobatake M 1984. Ecology and control of spotted wilt disease of tomato in Nara Prefecture. Proceedings of the Kansai Plant Protection Society 26: 23-28. [in Japanese]

Kumm S 2002. Reproduction, progenesis, and embryogenesis of thrips (Thysanoptera, Insecta). PhD thesis. Martin Luther Universität, Halle-Wittenberg, Germany.

Miyazaki M & Kudo I 1986. descriptions of thrips larvae which are noteworthy on cultivated plants (Thysanoptera: Thripidae). I. Species occurring on solaneceous and cucurbitaceous crops. Akitu 79: 1-26.

Miyazaki M & Kudo I 1988. Bibliography and host plant catalogue of Thysanoptera of Japan. National Institute of Agro-Environmental Sciences. Miscellaneous Publication 3: 1-246.

Mizobuchi M, Fujiwara Y, Kobayashi K & Ikawa Y 1991. Notes on thrips (Thysanoptera) collected in and around ports of Kobe, Himeji, Uno and Hirao. Research Bulletin of plant Protection of Japan 27: 115-127. [In Japanese]

Mochizuki M 2014. Seasonal occurrence and species composition of phytoseiid mites and phytophagous thrips on forage soybean with a view to conservation of phytoseiid mites in vineyards. Journal of the Acarological Society of Japan. 23: 79-89. [In Japanese]

Mound LA 2005. Japanese flower thrips. *Thrips setosus*. Available at: www.padil.gov.au/pests-and-diseases/pest/pests-and-diseases-distribution/136443. [Consulted 6 March 2015]

Mound LA & Teulon DAJ 1995. Thysanoptera as phytophagous opportunists. In: Thrips Biology and Management. NATO ASI Series A. Life Sciences 276 (Parker BL, Skinner M & Lewis T eds): 3-20. Plenum Press.

Murai T 2001a. Life history study of *Thrips setosus*. Entomologia Experimentalis et Applicata 100: 245-251.

Murai T 2001b. The pest and vector from the East: *Thrips palmi*. In: Thrips and Tospoviruses: Proceedings of the 7th International Symposium on Thysanoptera. Italy, 2-7 July 2001 (Marullo R & Mound LA eds): 19-32. Australian National Insect Collection.

Nakao S 1998. Effects of photoperiod and temperature on induction and termination of reproductive diapause of *Thrips setosus* Moulton (Thysanoptera: Thripidae). Japanese Journal of Applied Entomology and Zoology 42: 172-173. [In Japanese]

Palmer JM 1992. Thrips (Thysanoptera) from Pakistan to the Pacific: a review. Bulletin of the British Museum (Natural History) Entomology 61:1-76.

Umeya K, Kudo I & Miyazaki M 1988. Pest thrips in Japan. Zenkoku Noson Kyoiku Kyokai Publishing Co.

Vierbergen G 1995. International movement, detection and quarantine of Thysanoptera pests. In: Thrips Biology and Management. NATO ASI Series A. Life Sciences 276 (Parker BL, Skinner M & Lewis T eds): 119-132. Plenum Press.

Vierbergen G, Kucharczyk H & Kirk WDJ 2010. A key to the second instar larvae of the Thripidae of the Western Palaearctic region (Thysanoptera). Tijdschrift voor Entomologie 153: 99-160.

Woo KS 1974. Thysanoptera of Korea. The Korean Journal of Entomology 4: 1-90.

Woo KS & Choo HY 1986. Distribution and control of thrips on fruit and seasoning vegetables. The Research Reports of the Rural Development Administration (Agri Institutional Cooperation): 163-167. [In Korean]

Zur Strassen R 2003. Die terebranten Thysanopteren Europas und des Mittelmeer-Gebietes. Die Tierwelt Deutschlands 74: 1-271.

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Samenvatting

Thrips setosus (Thysanoptera: Thripidae), de Japanse bloementrips, in de teelt van _Hydrangea_ in Nederland

Thrips setosus, een uit Japan en Korea bekende tripssoort, is voor de eerste maal in Nederland gevonden. Op 30 september 2014 werden door de Nederlandse Algemene Kwaliteitsdienst Tuinbouw 22 vrouwelijke dieren en vijf larven verzameld van aangetaste *Hydrangea*-planten bij een teler in Kudelstaart. Hortensia (*Hydrangea*) was tot nu toe een onbekende waardplant voor deze soort. Het aantal intercepties in de internationale handel van deze polyfage trips en vector van het tomatenbronsvlekkenvirus is zeer gering. Tevens is de trips niet eerder aangemerkt als een invasieve soort. Een korte risicoanalyse (quickscan) leidde tot het uitvoeren van een survey bij *Hydrangea*-telers in Nederland. De resultaten van deze survey hebben niet geleid tot een indicatie van de herkomst van de introductie, wel dat er vestiging op een aantal bedrijven had plaatsgevonden en dat ontwikkeling ook op natuurlijke vegetatie in de open lucht plaats kan vinden. De NVWA heeft besloten zich niet te richten op eliminatie van deze populatie, maar om nationale en internationale gewasbeschermingsorganisaties in te lichten over deze nieuwe trips in Europa. De identificatieprocedure en resultaten van de survey zijn hier gepresenteerd.

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