Aceria kuko Mites: a Comprehensive Review of their Phytosanitary Risk, Pathways and Control

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BulletinUASVM Horticulture 73(2) / 2016

Print ISSN 1843-5254, Electronic ISSN 1843-5394

DOI:10.15835/buasvmcn-hort:12264

Abstract

The present review aims to identify the phytosanitary risk, the dissemination pathways and the possible control methods of *Aceria kuko*, the goji-berries gall mite, which was imported to Europe from China via orders by mail in 2007. Despite the first eradication measures taken by the UK in 2008 and Germany in 2011, the pest was found again in Germany (2012), in Slovenia (2012), in Cyprus (2013), in Romania (2013), in Hungary (2014) and in Serbia (2015). Although the import of *Solanaceae* intended for planting is prohibited in Europe, the parcels ordered by mail escape the pest and disease control services. Our field observations regarding the attack frequency, attack intensity and the losses indicate that *Aceria kuko* is a potential threat for goji growers. Monitoring the presence of the mite in the Romanian Goji plantations should therefore be regarded as a biosafety measure not only for Romania, but for entire Europe.

Keywords: *Aceria kuko*, biosafety, *Lycium barbarum*, nonindigenous pest, pest risk assessment

INTRODUCTION

Global trade has been widely acknowledged as one of the leading causes of the introduction of invasive alien species (IAS) on a new territory (Colunga-Garcia *et al.*, 2013) and the total “monetary impacts of IAS in Europe amount to a total of 12.5 billion EUR/year” (Kettunen *et al.*, 2008). All around the globe, the Internet sales represent a serious threat, as the undetected, alien species may bypass the pest quarantine and control services. As example, in UK, the purchasing of plants from larger traders who have their own websites, from the small companies or nurseries that promote their products on E-commerce websites, from the private persons who uses the sharing/trading websites or from national newspapers and magazines that runs special promotion for plants supplying is considered an increasing trend, but in the same time a major threat (Giltrap *et al.*, 2009).

The goji berries gall mite, *Aceria kuko* (Kishida, 1927) belongs to the *Eriophyidae* family and its genus, *Aceria*, includes over 900 species which are known to be taxonomically problematic (Magud *et al.*, 2007). Navia *et al.*, in 2009, conclude that because of their very small size, that makes them difficult to be detected and so easily distributed by world trade, *Eriophyid* mites have a high potential as invasive alien species. The new goji pest had been for the first time reported on the European territory of United Kingdom, in April 2008, and was discovered by chance, following one regular inspection of some goji plants in a nursery in Guernsey. Following this inspection, an entire business of illegal import of goji plants was discovered (Anderson and Ostoj-Starzewski, 2009; Giltrap *et al.*, 2009). The European and Mediterranean Plant Protection Organization (EPPO) mentioned the new finding and the actions

taken by the UK authorities in EPPO RS 2008/222, stating that “in August and September 2008, samples of severely distorted leaves of ‘Goji’ plants were received by the Central Science Laboratory (CSL) from 3 geographically distant parts of England (...) The infested plants were destroyed and further surveillance will be carried out by phytosanitary inspectors. Publicity and advice will continue to be given to attract the attention of the general public to the risks presented by these illegal imports of *Lycium* spp. plants.” Following this first record, *Aceria kuko* was reported again in 2011 in Germany (EPPO RS 2011/218; Steinmüller and Unger, 2012), then again in 2012 in Germany (EPPO RS 2012/233), in Slovenia (Seljak, 2013), in 2013 in Cyprus (Seraphides, 2014), in Serbia in 2014 (Vidović *et al.*, 2015), in Hungary in 2015 (Ripka *et al.*, 2015). Despite the first eradication measures taken by the UK in 2008 and Germany in 2011, the pest was found again in these countries. It has to be said that in the EPPO Global Database, EPPO code ACEIKU, the *Aceria kuko* mite distribution was last updated on 14 January 2013, when only two European countries – Germany and the United Kingdom, mentioned to have identified the pest on their territory. Germany appears with the status “transient, under eradication” while in the United Kingdom the pest status is “absent, intercepted only”. Those statuses are justified by the intensive eradication measures taken by the two countries at that time, to eliminate the new alien pest.

It has neither been proved that the undertaken eradication measures in those two countries were effective, nor that the illegal import of plants has stopped in other European countries.

In Romania, until the present moment there are only 3 mentions of the presence of *Aceria kuko*, one in 2013 (Mencinicopschi and Balan, 2013b), one in 2014 (Balan *et al.*, 2014) and the last one in 2015 (Chireceanu *et al.*, 2015), all three being presumptively from the same place in Bucharest. The possibility to have *Aceria kuko* in our country even before this date is high, as imports of Goji plants originated from China started long before this date. Actually, the pest had been identified on imported goji plants, planted in 2010 for a field trial of a doctoral thesis (Mencinicopschi and Balan, 2013 a,c). The author only mentions that the pest had been reported in UK, Japan and Holland, but states that the data are uncertain, as some authors affirm that *Aceria kuko* is monophagous on *Lycium*

chinense (Huang, 2008). The same doubt had had also the first researchers who had identified the pest in the UK (Ostoja-Starzewski, 2009). In the paper published in 2014, Balan *et al.* mention that one *Lycium barbarum* biotype was vulnerable to powdery mildew and “to the *Aceria kuko* gall mite’s attack, the degree of attack being 41%. The mite is specific to *Lycium* species and probably came with the biological material, although it was not observed at planting. However, it should be noted that neither fruit quantity nor quality was negatively affected.” Our field observation depicts a different situation, as it will be further presented. Chireceanu *et al.*, in 2015, mentions the European countries where the pest had been reported till 2015 - United Kingdom, Netherlands, Greece and Slovenia and the fact that the pests develop on *L. chinense*, *L. barbarum*, *Solanum nigrum* and *Capsicum annuum*. The authors affirm that the pest was identified in a research experimental field and that it was introduced “with the infested plant material brought from China”, insisting on the fact that the plants were heavily affected and that the pest “could be a threat to the cultures of economic interest of Solanaceae family”.

A complete overview of the threats that *Aceria kuko* might raise for Europe would not be complete without analysing the situation of its host plant. *Lycium barbarum*, popularly known as wolfberry or “goji” from the Chinese “gou qi”, had been extensively advertised as the “superfruit” of the century, having major sanogenic properties (Mencinicopschi *et al.*, 2012). In their review from 2011, Amagase and Farnsworth mention that the studies on *L. barbarum* indicate its effects on “aging, neuroprotection, general well-being, fatigue/endurance, metabolism/energy expenditure, glucose control in diabetics, glaucoma, anti-oxidant properties, immunomodulation, antitumor activity and cytoprotection”. Having this said, it is understandable why the imports of goji plants intended for planting have increased dramatically in the recent years (Potterat, 2009). In the same time, *Lycium barbarum* grows wild into Europe and is considered by some scientist either a sub-spontaneous, naturalized plant (Doroftei *et al.*, 2005) either an invasive plant (Anastasiu *et al.*, 2005, Paukova 2013). It is a hemerophyte plant (introduced from elsewhere cultivated plant) (Ferus *et al.*, 2015) neophyte plant (recently introduced plant in an area), initially introduced

as ornamental, although the first mention as a wild plant dates since 1842-1848 in Moldova (Culita S, 2007), both an anthropochorous (seeds transported by human actions, typically inadvertent, into new geographical areas) and endozochorous plant (seed dispersal realized by animal ingestion) (Ferus *et al.* 2015). Goji plants belong to the *Solanaceous* family, which means they are susceptible to certain dangerous pests and diseases common with plants of economic importance, such as potato, pepper or tomato and as they are perennials and relatively winter hardy plants, they have the potential to be a major source of pest and diseases for a long time. Because *Lycium barbarum* grows wild, its infestation with a new pathogen could act as a secondary source of infection for subsequent years.

In the present review, we aim to demonstrate that *Aceria kuko* represents a potential threat and should be considered as the starting point for the elaboration of preventive and eradication control measures for the living plant material imported by mail from third countries. The lack of scientific evidence about the damages produced by *Aceria kuko* on different Solanaceae plants should not be used by Romanian authorities as a reason for postponing the appropriate containment and control measures. In Cyprus case, the discovery of the pest in 2013 led to financial support coming from EU Commission, for the eradication measures taken by Cyprus in 2014 (EU Commission, 2016). Until the present moment, from Romania, no information has been transmitted to the EPPO services, either no eradication, curative or preventive measure has been mentioned. As the imports via internet from China increase in the last years, especially for living plants and the mailed parcels are usually inadequately verified, the risk of introducing other non-native pests in Europe is very high.

MATERIALS AND METHODS

For the present paper were used all the available online and offline bibliographical references we could find, using the following international databases: Web of Science - Core Collection (Journal Citation Reports, Derwent Innovations Index, Thomson Reuters), SpringerLink Journals (Springer), Scopus (Elsevier), ScienceDirect Freedom Collection (Elsevier), PROQUEST Central,

Oxford Journals, CAB Abstracts, Google Scholar, AgrisFao, simple google research.

Although the present article is a review, considering the fact that we did not publish yet our own research results, we will also use some unpublished pictures and data, as they are considered necessary to demonstrate the actual situation in Romania. Our observations were made in the experimental field of USAMV Bucharest, both on potted (one-year-old plants) and planted in the field goji-berries plants (six years old plants). Our research focused on the determinations regarding the attack frequency, attack intensity and the attack degree caused by the goji gall mite. For our calculation, we used the following formulas:

The attack frequency F(%)

$$F(\%) = \frac{n}{N} \times 100$$

N = the number of plants observed and n = the number of plants showing specific attack symptoms;

$$I(\%) = \frac{\sum(i \times f)}{n}$$

The attack intensity, i = % of plants presenting the attack symptoms, f = the number of plants with the specific % of attack, n = the total number of plants attacked;

$$Ga(\%) = \frac{F(\%) \times I(\%)}{100}$$

The attack degree, F(%) = attack frequency and I(%) = the attack intensity

PHYTOSANITARY RISK

The bibliographical references state that the phytosanitary risk associated with the presence of *Aceria kuko* is low, as there are no known data about the damages and economic losses caused by the pest on other crops, other than *Lycium barbarum* and *Lycium chinense*, crops that are specific to China. Despite this, Hong *et al.* (2006) have included the mite in the list of invasive eriophyid mites of economic importance in China. Analysing the potential threats, we could summarize that there are four major types of phytosanitary risk, of which three have been already documented (figure 1).

1. *The risk for goji berries producers.* In Europe, the risk for the goji berries producers is considered small, as there is no economic goji

Fig. 1. The four possible different types of phytosanitary risk associated with the presence of *Aceria kuko* mite in Europe

production in the area, the majority of producers being amateurs. On the other hand, goji had become extremely popular in the recent years, and a growing number of people are living from selling the goji berries or goji plants. Not many data are available about the goji producers in Europe and there is also a scarcity of data related to the number of goji growers and the entire cultivated goji area in Romania. Danaila-Guidea *et al.*, 2015, mention that a manufacturer in Ciuperceni village (15 kilometres away from Satu Mare, in northern Romania) has set up the first organic goji plantation in Europe, on an area of 2 hectares and from public TV and other internet sources we found out that he extend it to 12 ha (www.gojilandromania.eu). Agointel website, 2013, mention that Ms. Erzsebet Kolbaszer from Carei had in 2013 an area of 2.5 ha of goji and wanted to extend to 5 ha until the end of the year. On YouTube website, the keywords “goji and Romania” bring about 4730 results, and quite a few videos mention commercial goji plantations with a surface between 0.2 and 2 ha.

In 2014 Balan *et al.* concluded that either the fruit quantity and quality was negatively affected, but our observations depict a different situation and indicate either a change in pest virulence on its host plant either a better adaptation to the new climatic conditions that led to *Aceria's kuko* population proliferation. Despite the fact that the degree of attack might be appreciated below 50% for one of the plants, as the lower leaves of the shrub have fewer galls (figure 2), the young shoots

of the plants, were the flower and future fruit occurs, were completely damaged.

In 2016, in the UASVM Bucharest experimental fields, the attack frequency was 100% on goji biotypes V1 and V2, the attack intensity on leaves vary between 45% and 85% and the production losses in the month of June were estimated between 80% and 100%, as the majority of flowers buds were distorted by galls (figure 3).

The observations made in July and August on the fruits could not conclude to a clear comparison of the quantitative losses, as all the plants were infested and the majority of fruit stalks had at least 1 to 4 galls on them (figure 4).

Up to now, we knew that *A. kuko* is a thermophile species, having optimal development at temperature between 25 – 35°C. For the necessary minimum temperature for survival, an activity of the gall mites below 0°C was described (Anderson and Ostoja-Starzewski, 2010). It was assumed by Ostoja-Starzewski, 2009 that also an overwintering below bud scales and bark pieces is common and our observations show that the goji gall mites survives at least at temperatures of -25°C, which is a major adaptation at the new climatic factors and proves the species adaptability.

We consider that the presence of galls on stalks may interfere with the sap exchanges with the plant and presumptively can lead to qualitative and quantitative losses. The fact that the presence of galls on plants may lead, in the case of severe infestation, to the death of the plant, indicate the necessity of chemical intervention when the

Fig. 2. Comparison between a heavily infested goji branches and one only with few galls (14.06.2016)

Fig. 3. The flower buds completely destroyed by the galls formed by *Aceria kuko* (14.06.2016).

economic damage threshold is reached. Other *Aceria* species have been and are still used as biological agents for weeds control (Lipa, 1978; McClay *et al.*, 2013; Vacante, 2016). For example, *Aceria chondrillae* is often used as a biological control for the perennial herb skeleton weed (*Chondrilla juncea*) present in Europe, North America and Australia while *A. malherbae* was successfully used for the control of *Convolvulus arvensis* (McClay *et al.*, 2013). It was introduced to Australia in 1971 as part of a program to suppress skeleton weed in infested areas. The galls induced by the gall mites impede the growth and reproduction abilities of the plant by destroying the flower buds in gall formation, reducing or suppressing seed production and destroying the apical shoots. Kim, 1965, demonstrate that starting with the 15th day of their life, the mites feeding on the leaves galls destroy the chloroplasts from the leaves cells. The plants infested in an early stage

stopped their shoot development and the apical growth and the adjacent stems were distorted, leading to the death of the young plant (Cullen and Moore, 1983). Further research is necessary to identify the modifications in the plant metabolism, induced by the feeding process.

The goji plants produce the fruit continuously during the summer, from June to November (Balan *et al.*, 2014) and the application of systemic acaricides make the fruits improper for human consumption, from one day to another. For example, Griffith, 1985, for the *Aceria guerreronis* mite indicate the fact that a 5-month period is required for the fruits to be free of all pesticide residues (from treatment to harvest). For the goji producers, the necessity of using chemical plant protection products represents a serious problem, first because the majority of the goji producers prefer to be certified as organic farms, to obtain a higher income and second because the producers

Fig. 4. The *Aceria kuko* galls formed on fruit stalks (02.08.2016).

might lose a part of their production, because of the pause time imposed by each chemical product.

Another aspect to be considered is the possible dissemination pathway represented by seeds. The presence of mites on stalks of the fruit indicate also the possibility that the mite is disseminated easily by fruit and seeds, as in only one gall hundreds to thousands individuals may be observed.

2. *The risk for the sweet pepper producers.* The literature and the artificial infestation tests proved that *Aceria kuko* produce damages on sweet pepper (Kim, 1968; Ostojá-Starzewski 2009). In the period 2011-2013, the EU produced 2 259 thousand tonnes of sweet peppers per year (on average): three countries, Spain, the Netherlands and Italy, concentrated 69% of the total production (43%, 15% and 11%, respectively), while Romania produced on average 147,2 thousands of tones, representing 6,5 % from the total EU production (EU, 2014; faostat, 2016). A new eriophyid pest for sweet pepper would lead to great economic losses.

3. *The risk for other species belonging to Solanaceae family.* Until the present moment, the risk for other important Solanaceous crops is considered low, as no known data mentions *Aceria kuko* damaging other crops. Ostojá-Starzewski, 2009, in their tests, concluded that no transfer to tomato ('Moneymaker'), petunia ('Crown mix') and tobacco ('White burley') was successful. On the other hand, *Solanum nigrum*, a well-known weed and *Capsicum annuum*, are mentioned as being a host for the goji gall mite since 1968, Kim CH, so the mite it is not a "devoted" monophagous.

4. *The risk for other species, besides Solanaceae family.* As no record exists so far, this risk may

be considered insignificant and should be further investigated. Pallavi and Ramappa, 2014, demonstrate that *Aceria cajani*, another mite related to *Aceria kuko*, is the vector of pigeonpea sterility mosaic virus (PPSMV), so further studies should be conducted on the mite on the possibility of being a vector for viruses or other diseases.

DISSEMINATION PATHWAYS

The bibliographical references states that the pathways for the introduction of *Aceria kuko* mite (its first mention) in Europe are represented by illegal imports, as orders by mail, of dormant goji berry plants from China, via Netherlands (Ostojá-Starzewski, 2009; Andreson and Ostojá-Starzewski, 2009; Giltrap *et al.*, 2009). The discovery of the "goji gall mite, a species never before recorded in Europe" happened accidentally, when a Plant Health and Seeds Inspector was performing a routine control on some goji plant in a nursery (Giltrap *et al.*, 2009) so more attention should be given to the multiple ways that should be considered as possible pathways (figure 5).

The present geographical distribution of this pest is believed to be limited to south-east Asia, mainly China, Korea, Japan, Taiwan (Andreson and Ostojá-Starzewski, 2009).

Dissemination over long distances

From a country to another, the mites are dispersed only with their host. According to Kim (1968) the adults of *A. kuko* overwinters in the leaf galls, but all the observations made in Europe since 2008 demonstrate that the populations of *A.*

Fig. 5. The possible pathways of *Aceria kuko* mite spreading on European territory.

kuko also overwinter on buds and bark (Ostojá-Starzewski, 2009).

1. *The trade of infested Solanaceous plants intended for planting from third countries other than European and Mediterranean countries.* Ostojá-Starzewski, 2009, Andreson and Ostojá-Starzewski, 2009 and Giltrap *et al.*, 2009 illustrate the case study of illegal import in the UK of goji berry plants from China via the Netherlands. In Europe, the import of Solanaceous plants intended for planting is prohibited according to Dir. 2000/29/EC, in order to protect the other main Solanaceous crops of high economic importance (tomatoes, pepper etc.) to be infected by newly alien pests. Despite this, Giltrap *et al.*, 2009 states that in the UK, “in 2007, 38 000 goji plants had been sent by mail to 8000 customers (...) while in 2008, 45 000 plants had been supplied to 19 000 customers”. An important aspect that deserves attention is the fact that although Kim (1968) concluded that the adults of *A. kuko* overwinter in the leaf galls, the mites found in Europe overwinter under the buds or bark crevices, as the imported plants had no leaves. Our own observations show that *A. kuko* produces galls also on young branches (figure 4), an important key factor for rapid, visual identification of defoliated plants.

2. *The trade of infested Solanaceous plants intended for planting from European and Mediterranean countries.* As Ostojá-Starzewski,

2009, Andreson and Ostojá-Starzewski, 2009 and Giltrap *et al.*, 2009 mention, the infested plants have been imported in the UK from the Netherlands. As the internet trade for plants for planting is increasingly popular (Giltrap, 2009), the intracommunity trade is not regulated and the mailed parcels are not subject to appropriate control measures, it is predictable that the spread of the mite will continue around EU countries. The presence of the pest in Greece is mentioned as result of imported plant material from Germany (Bardas, 2012) while in Serbia it is not stated the source of the plants, but given the fact that the mite was found in a 0.5 ha plantation, it is reasonable to assume that the plant material was bought from Europe. Although there is no information about the phytosanitary condition of the plants, on a website named agointel, in 2012, there is a mention about a Romanian researcher and goji producer that sold in 2012 goji plants for 40 ha goji plantation in Greece.

3. *Trade with infested seeds and fruits from third countries, other than European and Mediterranean countries.* The plants from the experimental field from Romania were produced also from seeds imported from China, so this pathway is totally valid. Considering the fact that the adult mites are extremely small, measuring between 0.17-0.25 mm in length by 0.055 mm in width and also have a very difficult colour to see (pale salmon

pink) (Ostoja-Starzewski, 2009; Pipka *et al.* 2015) they are very difficult to see in the field or on the planting material or seeds. This pathway is not documented for the moment and it has to be further investigated.

4. *Trade with infested seeds and fruits from inside the EU borders.* Our observations show that the mite *Aceria kuko* can survive on the fruits and eventually infest the newly grown plants. This pathway is also not documented for the moment and it has to be further investigated.

5. *The trade of infested Solanaceous plants intended for planting inside of a country.* The plants presenting the distorted by galls leaves were bought from the UK, after they were imported from Netherlands, from Guernsey, Channel Islands. In Romania, the number of goji plants imported from China is practically impossible to be stated, as no evidence seems to be held by Romanian authorities. By reading the forums of goji amateurs and producers, some information can show out. In one conversation, a goji nurseryman states that he had imported from China seeds of *Lycium barbarum*, var. Ningxia nq1 (actually Ning Qi 1, a.n.) and that he had sent plants in Romania, Republic of Moldova, Greece, Spain, Italy, Poland and only in 2013 he had produced more than 200000 plants (Marin, 2013)

6. *Accidental contamination as a result of trade exchanges.* Ferus *et al.*, 2015 demonstrates that seeds and fruits of *Lycium barbarum* arrived on Slovakian territory, in a study about reciprocal contamination of invasive plants in the period 2006-2010. The theoretical quantities of *Lycium barbarum* seeds exported into Slovakia into the 5 years of study exceeded 35 t. If we consider that fruits of *Lycium barbarum* may be infested, the possibility of spreading into Europe by export is proven.

According to the bibliographical records that could have been found until august 2016, the history of *Aceria kuko* on European territory can be summarized as illustrated in table 1.

Dissemination in the surroundings

While the pathways to introduce the pest on a new territory had been presented above, the dissemination of the existing populations in the surroundings happens by passive dispersal either by wind currents (it was proved that wind direction influences the migration and dispersal

of *A. kuko* by Kim in 1968), either by phoresy on insects and birds (Ostoja-Starzewski, 2009). Michalska *et al.*, 2009 cites leafhoppers as general carriers of *Aceria* species while ambulatory and rain mode of dispersal was observed only in few *Aceria* species.

CONTROL

The identification of alien pests into a new territory must always be treated with precaution, especially when the respective pest represents a threat in its native location. According to the Convention on biological diversity, 2002, "*the lack of scientific certainty about the various implications of an invasion should not be used as a reason for postponing or failing to take appropriate eradication, containment and control measures*". The general term of control integrates in the present review all three components of the precautionary approach, the eradication, containment and control measures respectively.

1. *Eradication.* In UK, the Plant Health Authorities took all the necessary measures to eradicate the mite populations identified in the 3 different regions of the country, among which withdrawing from sale of all known illegally imported 'goji berry' plants from plant nurseries and garden centres and followed either by their destruction or re-export (defra 2008), media publicity about the risk of having infested goji plants, sending informing letters to all customers who bought directly from a mail order companies. In all the places where *Aceria kuko* mite was identified, the plants were voluntarily destroyed by owners and the Solanaceous plants around them were carefully checked. The Plant Health Authorities carry out continuous surveillance and supplement the publicity and advice for all the potential goji owners. The destruction of the plants that were illegally imported is still recommended, considering the potential threat (Anderson and Ostoja-Starzewski, 2009).

In Germany, all known infested sites were subject to an intensive eradication programme, after the first finding, in Baden-Württemberg, in 2011. After the official inspections of nurseries that were conducted in most German regions in 2012, the mite was found again in Berlin, Bayern, NordrheinWestfalen, Rheinland-Pfalz, Sachsen, and Schleswig-Holstein. In all sites, official control measures were taken during 2012

Tab. 1. The presence of *Aceria kuko* on European territory and the control action taken

Country	Year	Region, place	Control action taken	Bibliographical source
United Kingdom	2008	York in North Yorkshire, Selsey in West Sussex and Reading in Berkshire	All infested plants were destroyed	Ostoja-Starzewski (2008) EPPO RS (2008/222) Anderson and Ostoja-Starzewski(2009)
Germany	2011	Baden-Württemberg, in orchard for fruit production	Under eradication	EPPO RS (2011/218)
Germany	2012	Berlin, Baden-Württemberg, Bayern, Nordrhein-Westfalen, Rheinland-Pfalz, Sachsen, Schleswig-Holstein	Transient, actionable, under eradication	EPPO RS (2012/233)
Slovenia	2012	Maribor and Ljubljana	Transitional, no actions mentioned	Seljak (2013)
Romania	2013	Bucharest	No action taken until 2016	Mencinicopschi 2013b,c, Balan 2014 Chireceanu 2015.
Hungary	2014	Heves, Budapest and Sasad	Not stated	Ripka (2015)
Cyprus	2014	Nicosia	Eradication and containment	Seraphides 2014
Serbia	2015	Sombor in a private orchard <i>L. chinense</i> area of 0.5 ha.	Not stated	Vidovik 2015

including the destruction of infested plants (in Bayern, Schleswig-Holstein, Rheinland-Pfalz), chemical treatments with acaricide, quarantine measures, official inspections in nurseries (EPPO RS 2012/233).

2. Containment. As the goji gall mite continued its spread in other countries in 2013 and 2014, EU started to take special measures. The fact that EU authorities admit the threat represented by *Aceria kuko* is proven by the fact that EU Commission awarded financial support to Cyprus, for the measures taken by this country to control the mite in the Nicosia area in the year 2014. The Commission Implementing the Decision of 18.03.2016 (Brussels, 2016) states that “Measures against pests of the types *Aceria kuko*, *Anoplophora chinensis*, *Anoplophora glabripennis*, and *Bursaphelenchu xylophilus* may qualify for grants pursuant to Article 17 of Regulation (EU) No 652/2014.” As “Cyprus submitted an application for Union funding on 18 September 2014 in relation to the measures implemented in 2014 to eradicate or contain *Aceria kuko* in Nicosia area”, the EU decided that Cyprus will receive EUR 32 983 for the measures implemented against *Aceria kuko* in the area of Nicosia.

In the same time attention should be drawn on the fact that in the UK, the most of those goji plants that were sold by mail order between May and October 2007 and during April 2008 were not identified, only a few individual plants being reported after the public queries of Plant Health Authorities and media publicity. All the ones who purchased plants via a newspaper were either not contacted or identified. The large numbers of goji plants involved (83.000 plants) and potentially widespread around the country suggests that if *Aceria kuko* was present on those plants, pest establishing is undergoing and without knowledge of the locations of all the goji berry plants, the UK cannot guarantee that they eradicate the pest.

3. Control measures. In the US, Maughan and Black, 2015 states that as goji is still a new crop, the pest information is limited and the only pest reported on goji in Utah is *A. kuko*. Their recommended control measures include sulphur, insecticidal soap or horticultural oil (0.5% solution), only under the limit of 32°C or horticultural oil 2%, either in the fall, just before leaves drop) or in the spring (just as leaves emerge).

There were no scientific studies found regarding either mechanical, chemical or biological control methods of *Aceria kuko* in Europe.

CONCLUSIONS

Currently, the trade barriers and sanitary and phytosanitary measures (SPS measures) are of great interest worldwide. The trade-offs between economic profitability and the risks raised by new invasive alien species into Europe are to be addressed in future studies.

Upon our knowledge, at this moment there is no implemented and functional service to prevent the intrusion of nonindigenous species by mail in Romania, although for example, the Dir. 2000/29/EC regulates the import of living plant material belonging to Solanaceous family.

The overwintering at -25°C, a major adaptation at the new climatic factors, proves the species adaptability and should be regarded as an additional warning sign.

Considering the phytosanitary risk, pathways and the difficult control methods for the plants imported via orders by Internet, integrating invasive alien species prevention measures into the international trade rules should be considered a must. National, regional and international precaution and prevention measures should be implemented and awareness among the passionate gardeners or small agricultural producers who regularly order from internet or newsletters campaigns should be raised.

We appreciate that (minimum) 3 years without any control measures in Romania were long enough to help the dissemination of the pest in the country and we consider that field inspections of all major Goji growers and in their nurseries are mandatory for monitoring the occurrence of *A. kuko* in Romania (both on goji berries plants and on the Solanaceous plants). And, as many other plants are coming from China by mail, we state that there was enough time for the new adventive species (also known as invasive alien species) to adapt to our climatic conditions. We consider the study of *A. kuko* biology and ecology features in Romanian environment to be the promoter of a new step in plant protection against new alien species.

We consider the *Aceria kuko* case study as a substantiation of using citizen science not only

for biodiversity monitoring but also in matters concerning alien pest species.

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