**European and Mediterranean Plant Protection Organization**
**Organisation Européenne et Méditerranéenne pour la Protection des Plantes**

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# Report of a Pest Risk Analysis for *Microstegium vimineum*

This summary presents the main features of a pest risk analysis which has been conducted on *Microstegium vimineum*, according to EPPO Decision-support scheme for quarantine pests (EPPO Standard PM 5/3(5)). The full PRA record is also available (EPPO (2014) Pest risk analysis for *Microstegium vimineum*, at http://www.eppo.int/QUARANTINE/Pest_Risk_Analysis/PRA_intro.htm).

**Pest:** ***Microstegium vimineum*** **(Trin.) A. Camus**

**PRA area:** EPPO region

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A preliminary draft was prepared by Ms Asuman Ergün (PPO of Turkey). This document has been reviewed by the EWG that met at the EPPO Headquarters in Paris, France on 2014-10-21/24. The PRA was reviewed by the Panel on Invasive Alien Plants on 2015-05-07.

## STAGE 1: INITIATION

**Reason for doing PRA**: *Microstegium vimineum* possesses characteristics typical of many invasive alien species: it grows quickly, fruits within a single season, produces abundant seed, and readily invades habitats that have been disturbed by natural (e.g., flood scouring) and anthropogenic (e.g., mowing, tilling) sources. It is also capable of invading wildland areas and swiftly replacing natural communities with nearly monospecific stands (Tu, 2000; Oswalt, 2007). With the discovery of *M. vimineum* in Turkey and southern Caucasus, the European and Mediterranean Plant Protection Organization (EPPO) added the species to the EPPO Alert List in 2008 and transferred it to the List of Invasive Alien Plants in 2012 labelling it as an emerging invasive alien species considering the outputs of the EPPO Prioritization process for this species.

**Taxonomic position of pest:** Reign: Plantae; Family: Poaceae; Genus: *Microstegium*; Species: *Microstegium vimineum* (Trin.) A. Camus

## STAGE 2: PEST RISK ASSESSMENT

### PROBABILITY OF INTRODUCTION

***Entry***

Geographical distribution:
(see PRA record for references and for distribution details in EPPO countries)

*Native distribution:*
Asia: Bhutan, China (Anhui, Fujian, Guangdong, Guangxi, Guizhou, Hebei, Henan, Hubei, Hunana, Jiangsu, Jiangxi, Jilin, Shaanxi, Shandong, Shanxi, Sichuan, Yunnan, Zheijiang), India (Himachal Pradesh, Meghalaya, Nagaland, Sikkim, Uttarakhand, West Bengal), Iran, Japan (Hokkaido, Honshu, Kyushu, Ryukyu Islands, Shikoku), Myanmar, Nepal, Philippines, Taiwan, Thailand, Vietnam.

Note: the species is often recorded as native from Malaysia, though, there is no original source for this information and there are no herbarium records for this country. The species is also recorded in Armenia, but no original source could be retrieved for this record.

**EPPO region**: Russia (Primorye).

*Exotic distribution:*
**EPPO region:** Azerbaijan, Georgia, Russia (Northern Caucasus), Turkey.
**Central America**: Costa Rica, Puerto Rico.
**North America**: United States of America (Alabama, Arkansas, Connecticut, Delaware, District of Columbia, Florida, Georgia, Illinois, Indiana, Kentucky, Louisiana, Maryland, Massachusetts, Mississippi, Missouri, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Virginia, West Virginia).

Note: there is a Herbarium record of the species in the Democratic Republic of Congo from 1929. There is no additional record since that date, thus the record is then not interpreted as an established population in the absence of further information. *M. vimineum* was first noted in North America around 1919 in Tennessee, where it was probably introduced accidentally (Fryer, 2011).

Major habitats:
(see PRA record for references)

*M. vimineum* colonizes riparian habitats, lawns, woodland thickets, damp fields, managed forests, forest plantations and roadside ditches (Tu, 2000). These habitats are present in the EPPO region.

Which pathway(s) is the pest likely to be introduced on:

Entries as a contaminant of travellers (their clothes and shoes), machinery, hay, bird seed and soil have been important pathways for the introduction of *M. vimineum* in new regions. The following pathways are considered further in the assessment:

*As a contaminant of used machinery*
Used machinery, vehicles, equipment are regulated articles frequently traded or otherwise moved between countries. They may have been used in agriculture, forestry and horticulture, as well as for construction, industrial purposes, mining and waste management. They can also be used military vehicles, machinery and equipment, although movement through such machinery has not been documented. Depending on their use before export, they may have become contaminated with pests. When moved internationally as either a traded commodity or an operational relocation (e.g., in the case of custom harvesters) the used vehicles, machinery and equipment can carry soil, pests, plant debris, and seeds and plants as pests, and they may therefore present a pest risk to the importing country. Depending on their use in the country of import, they may introduce quarantine pests to agricultural, forested, wilderness or other areas (IPPC, 2006). *M. vimineum* have been observed being transported on automobiles in the USA (Mehrhoff, 2000). In addition, roads play an important role in

plant invasions (Trombulak & Frissell, 2000, Mortensen *et al*., 2009). Road grading and construction equipment also represent a high risk (Mortensen *et al*., 2009). *M. vimineum* was present in every location where there was vehicle movement in the USA (Shelton, 2010). Movement of agricultural machinery is considered a possible pathway for the entry and spread of *M. vimineum*.

*As a contaminant of bird seed*
The import of foreign seed as foodstuffs for domestic and cage birds is a major source of introduction of aliens which has received little attention or detailed study. The most regular weeds are those whose seeds closely resemble the main bird food plants (Hanson & Mason, 1985). One of them is *Microstegium vimineum* which was introduced into Britain in birdseed. It was detected by the cultivation of samples of bird seed and the waste separated from commercial seed carried out by the authors (Hanson & Mason, 1985). In the British Isles, the plant is recorded to have been cultivated from bird seed (Ryves, Clement & Foster, 1996)

*As a contaminant of growing media adherent to plants for planting*
An individual plant of *M. vimineum* can produce thousands of seeds (Wilson *et al*., 2014), which remain viable in the soil for three to five years (Barden, 1987; Gibson et al., 2002, Judge, 2006; Huebner, 2011). Seeds may be present in growing media adherent to plants for planting. Movement of plants for planting with adherent soil exists among EPPO countries.

*As a contaminant of travellers, their clothes and shoes*
Material susceptible to be contaminated is: clothing, boot or shoe treads. The fruit or caryopsis (grain) is yellowish to reddish, and ellipsoid in shape, less than 5 mm, it can attach to clothing and shoes. Adhesion of fruits to passing hikers is thought to explain the spread of *M. vimineum* through otherwise undisturbed natural areas in the USA (Miller 2011). Furthermore, the plant forms near monospecific stands in habitats susceptible for people to walk in (e.g. woodlands, roadsides, etc.).

***Establishment***

Habitats at risk in the PRA area: The following list summarizes the main habitats in which *M. vimineum* could occur in the EPPO region, according to the EUNIS habitats classification:
http://eunis.eea.europa.eu/habitats-code-browser.jsp?
C : Inland surface waters
C3 : Littoral zone of inland surface waterbodies
D : Mires, bogs and fens
E : Grasslands and lands dominated by forbs, mosses or lichens
E2 : Mesic grasslands
E3 : Seasonally wet and wet grasslands
E5 : Woodland fringes and clearings and tall forb stands
E7 : Sparsely wooded grasslands, woodland, forest and other wooded land
G1 : Broadleaved deciduous woodland
G2 : Broadleaved evergreen woodland
G3 : Coniferous woodland
G4 : Mixed deciduous and coniferous woodland
G5 : Lines of trees, small anthropogenic woodlands, recently felled woodland, early-stage woodland and coppice
H5 : Miscellaneous inland habitats with very sparse or no vegetation
H5.5 : Burnt areas with very sparse or no vegetation
I : Regularly or recently cultivated agricultural, horticultural and domestic habitats
I1 : Arable land and market gardens

I2 : Cultivated areas of gardens and parks
J : Constructed, industrial and other artificial habitats
J4 : Transport networks and other constructed hard-surfaced areas
J5 : Highly artificial man-made waters and associated structures
J6 : Waste deposits
X : Habitat complexes
X06 : Crops shaded by trees
X07 : Intensively-farmed crops interspersed with strips of natural and/or semi-natural vegetation
X09 : Pasture woods (with a tree layer overlying pasture)
X10 : Mosaic landscapes with a woodland element (bocages)
X11 : Large parks
X13 : Land sparsely wooded with broadleaved deciduous trees
X14 : Land sparsely wooded with broadleaved evergreen trees
X15 : Land sparsely wooded with coniferous trees
X16 : Land sparsely wooded with mixed broadleaved and coniferous trees
X20 : Treeline ecotones
X22 : Small city centre non-domestic gardens
X23 : Large non-domestic gardens
X24 : Domestic gardens of city and town centres
X25 : Domestic gardens of villages and urban peripheries

Climatic similarity of present distribution with PRA area (or parts thereof):

Largely similar
Level of uncertainty: low

*Microstegium vimineum* could present a risk to the EPPO region as eco-climatic conditions are similar to countries where the species occurs (Miller, 2011). *M. vimineum* grows in temperate to warm continental climates. These same climates are found throughout most of the EPPO region. There is little available specific information about temperature ranges for the species. *M. vimineum* grows in temperate to warm continental climates, so considering the Köppen-Geiger Climate Classification (Kottek *et. al.*, 2006), climatic conditions for the establishment of *M. vimineum* are largely similar to invaded countries such as the USA and Turkey as well as the native range. Since the distribution range *of M. vimineum* is very similar to climates in the EPPO region, it is considered that the species could establish further and a detailed mapping is not necessary. Where climate change is expected to decrease precipitation and soil moisture availability, *M. vimineum* invasion will become less likely, unless irrigation becomes more frequent. Where climate change is expected to raise temperatures without decreasing soil moisture, *M. vimineum* invasion may be facilitated. *M. vimineum* has invaded areas of the USA subject to frequent intense precipitation events such as hurricanes. Therefore increased precipitation intensity should not decrease likelihood of *M. vimineum* establishment, but may enhance the spread and establishment where flooding disturbance is becoming more common.

Characteristics (other than climatic) of the PRA area that would favour establishment:

*M. vimineum* occurs in a wide variety of abiotic conditions but is limited at very low soil moisture and light conditions. Adequate abiotic conditions for *M. vimineum* establishment are present throughout most of the EPPO region. Abiotic factors are largely similar to invaded countries such as the USA and Turkey as well as the native range.

Which part of the PRA area is the area of potential establishment:

The countries considered most at risk are: Austria, Azerbaijan, Belgium, Bosnia & Herzegovina, Bulgaria, Czech Republic, Croatia, Denmark, Former Yugoslav Republic of Macedonia, France, Georgia, Germany, Hungary, Ireland, Italy (in particular northern and Adriatic parts of the country), Kazakhstan, Moldova, Poland, Slovakia, Slovenia, Switzerland, the United Kingdom, Northern Spain, Northern Turkey, the Netherlands, Romania, Serbia, the coastal area of Norway, the coastal area of Sweden, southern areas in Ukraine, the Black Sea coast and southern in Russia.

Only irrigated or wet areas would be considered suitable in the following countries: Algeria, Cyprus, Jordan, Greece, Israel, Kyrgyzstan, Portugal, Morocco, Tunisia, Uzbekistan, southern Spain, southern Italy, southern and central parts of Turkey. Other countries including Estonia, Finland, Latvia, Lithuania, Russia, Ukraine, the northern parts of Norway and Sweden may be too cold for the species to establish. Nevertheless, the warmest parts of these countries may be suitable, considering that *M. vimineum* occurs in Kedrovaya pad (Siberia) in Russia.

## POTENTIAL ECONOMIC CONSEQUENCES

**How much economic impact does the pest have in its present distribution:**

Massive
Medium uncertainty

*Environmental impacts*

*M. vimineum* is listed by the US Forest Service as one of only 26 Category 1 invasive plants in the Eastern Region of the US, which are described as "Highly invasive plants which invade natural habitats and replace native species" (fs.fed.us). Furthermore, *M. vimineum* was recently ranked as the n°1 invasive plant of concern by researchers and land managers in the eastern USA (CWMA; mipn.org/cwma). *M. vimineum* threatens native understory vegetation in full sun to deep shade. It readily invades disturbed shaded areas, like floodplains that are prone to natural scouring, and areas subject to mowing, tilling and other soil-disturbing activities including white-tailed deer traffic. It spreads opportunistically following disturbance to form dense patches, displacing native wetland and forest vegetation as the patch expands (Swearingen *et. al.*, 2010). Invasions of *Microstegium* can quickly crowd out native species resulting in significant reductions in herbaceous species productivity and diversity. Invasions can also reduce tree regeneration and alter the growth of trees.

*Microstegium* invasion has cascading ecological effects on the arthropod community. The arthropod community was sampled in invaded and uninvaded plots on two dates, June and September. Invaded plots showed a 19 % decrease in arthropod richness and a 39 % decrease in arthropod abundance. Abundance and diversity of carnivores and herbivores arthropods was reduced, although the effect was much larger on carnivores (Flory, 2010). *M. vimineum* invasion poses a serious threat to ecosystems through changes in light availability, decomposition rates, and alteration of fire behaviour and carbon storage. *M. vimineum* has been shown to cause changes to nutrient cycling and availability, however the ultimate ecosystem impact remains unknown.

*Control costs*

*M. vimineum* is not currently considered an agronomic weed. However, extensive invasion occur in economically managed hardwood and pine forests in the USA and there is evidence that invasions can reduce natural tree regeneration (Flory & Clay, 2010; Oswalt *et al*., 2007). Invasions may also increase fire intensities and further reduce survival of tree seedlings (L Flory, pers. comm., 2014). It is unknown if documented reductions in tree seedlings survival are sufficient to affect stand-level dynamics.

There are reports of *M. vimineum* invasions in lawns and gardens, however control costs would be similar as for other minor weeds.

Differential effects on tree species may inhibit succession and cause a shift in forest community composition over time (Flory & Clay, 2010). The effect of invasion by *M. vimineum* on different tree life history stages was studied in a long-term experiment in Indiana. A subset of plots in a blocked design where either tree saplings were planted or tree seeds sown. Seeds were planted to simulate old-field succession, while planted

saplings simulated later successional stages. Some tree saplings showed higher mortality in invaded plots, and recruitment was more than four times greater than in invaded plots. Greater impact was observed for early successional simulations, particularly for small seeded tree species.

Though no reliable estimate exist, expenses associated with detection, monitoring and treatment of *M. vimineum* invasions are considerable.

*Social impacts*
There is no record whether the plant is allergenic or toxic to animals or not. Social damage can affect workers at timber industry because of unemployment, though there is no record on this point and the EWG considered that the level of impact on forests is unlikely to reach the level to cause unemployment. In the USA, environmental associations are paying close attention to this species and recommending changes in forestry management practices to avoid the spread of the species. In eastern USA, aesthetic impact is reported in many natural forested areas, although unstudied this has the potential to alter people's perception and uses of these areas.

**Describe damage to potential habitats in PRA area:**

*M. vimineum* has the potential to reduce tree recruitment in forest stands in the EPPO region, but its overall impact on commercial forestry is unknown. It is unlikely to affect timber volume. *M. vimineum* has the potential to negatively impact on biological diversity, ecosystem services and processes in the PRA area.

**How much economic impact would the pest have in the PRA area:**
Massive
Medium uncertainty

The direct economic impacts through timber loss or loss of recreational use have not been quantified. The environmental impacts in the eastern USA are massive thus the location, eradication and management of established *M. vimineum* in the EPPO region would be similarly massive.
The overall impacts on ecosystem services is assessed as massive, primarily because of the ability to alter the abundance, diversity and composition of plant communities, including herbaceous plants and trees. There are additional known effects on nitrogen and carbon cycling, fires, decomposition and other trophic levels (e.g. arthropods and birds).

**CONCLUSIONS OF PEST RISK ASSESSMENT**

**Summarize the major factors that influence the acceptability of the risk from this pest:**

*Microstegium vimineum* thrives along roadsides, ditches, woodlands, floodplains and stream, field margins and turfgrass (Fairbrothers & Gray, 1972; Hunt & Zaremba, 1992). It can also be found in mesic upland sites, and performs best in high light and high moisture conditions (Droste *et al.* 2010; Flory *et al*., 2011). It does not survive, however, in areas with periodic standing water (i.e., greater than one month).These habitats are widely present in the EPPO region. *Microstegium vimineum* could present a risk to the EPPO region as eco-climatic conditions are similar to countries where the species occurs (Miller, 2011).

**Estimate the probability of entry:**
Likely probability of entry
Low level of uncertainty

The probability of entry as a contaminant of used machinery and/or a contaminant of bird seed likely, as the species has already entered the EPPO region, and continues to enter, with a low level of uncertainty.

**Estimate the probability of establishment:**
Very high probability of establishment
Level of uncertainty: medium

*M. vimineum* is established in southern Caucasus including Azerbaijan, the Republic of Georgia, and Turkey. The species is also native to Russian Far East (Tsvelev, 1976) and introduced to Northern Caucasus (Valdés *et al.*, 2009). Given access to suitable habitats via its most frequent pathways, it is highly likely that *M. vimineum* will establish and spread within the

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| | EPPO region (it already established and spread in Turkey since 1997).Within the EPPO region, large areas exist where there is a confluence of suitable habitats, climate, abiotic factors and land management regimes (including transport infrastructure). Furthermore, *M. vimineum* has shown the ability to adapt rapidly to novel climates and increase its range (i.e. in the USA). |
| **Estimate the probability of spread:**<br>Medium rate of spread<br>Level of uncertainty: medium | Given access to suitable habitats via its most frequent pathways, it is highly likely that *M. vimineum* will establish and spread within the EPPO region (it already established and spread in Turkey since 1997).<br><br>Within the EPPO region, large areas exist where there is a confluence of suitable habitats, climate, abiotic factors and land management regimes (including transport infrastructure). Furthermore, *M. vimineum* has shown the ability to adapt rapidly to novel climates and increase its range (i.e. in the USA). Given the many potential natural and human-mediated pathways of spread and the rapid rate of spread in the USA, the overall rate of spread of *M. vimineum* is assessed as high. |
| **Estimate the potential economic impact:**<br>Major<br>Level of uncertainty: medium | The direct economic impacts through timber loss or loss of recreational use have not been quantified. The environmental impacts in the eastern USA are massive thus the location, eradication and management of established *M. vimineum* in the EPPO region would be similarly massive. |
| **Degree of uncertainty** | The overall level of uncertainty is assessed to be medium.<br>Areas where uncertainty remains are:<br>- The current distribution in the EPPO region;<br>- Adaptation to different day light in the Northern EPPO countries;<br>- Potential rate of spread of the species in the EPPO region;<br>- The locations of introduction, in particular through the travellers pathway;<br>- Effects on economic forestry. |
| **OVERALL CONCLUSIONS** | *M. vimineum* is considered to potentially have massive environmental impacts. The pest qualifies as a quarantine pest. |

## STAGE 3: PEST RISK MANAGEMENT

## IDENTIFICATION OF THE PATHWAYS

Following consideration of the pathways and potential measures, the EWG decided it would not be appropriate to recommend detailed measures for these pathways as it would not be feasible to implement measures just for this species alone. General considerations should be taken into account for the pathways under consideration where these measures should involve awareness raising, monitoring, containment and eradication measures. For most of these pathways regulation by means of horizontal measures would be more appropriate and for some, International Standards for phytosanitary measures are in preparation (Movement of growing media in association with plants for planting in international trade and International movement of used vehicles, machinery and equipment (see below)).

The Expert Working Group considered the following pathways for the introduction of *M. vimineum*:

1) Contaminant of bird seed
2) Contaminant of growing media adherent to plants for planting
3) Contaminant of used machinery
4) Contaminant of travellers, their clothes and shoes

**For 1:** Confirmation that the consignment is free from *Microstegium vimineum* seed should be provided by the country of origin. Surveillance and monitoring methods adopted should be specified by the exporting country.

**For 2**: In addition to the existing requirement for a phytosanitary certificate (PC) by the exporting country, confirmation of pest free production from country of origin should be provided. Surveillance and monitoring methods adopted should be specified by the exporting country. In certain circumstances, an additional declaration on the PC may be needed (see EPPO Standard PM 1/1(2) Use of phytosanitary certificates).

Also see:
Draft ISPM Standard: Movement of growing media in association with plants for planting in international trade (2005-004)
Standard PP 3/74(1) 'EPPO guidelines on the development of a code of conduct on horticulture and invasive alien plants' (EPPO, 2009).

**For 3**: Decontaminate machinery that has come into contact with populations of the plant. Raise awareness on the species, including publicity regarding its identification and its impacts to the sector in question.

Also see: Draft ISPM: International movement of used vehicles, machinery and equipment (IPPC, 2006-004).

**For 4:** Raise awareness in general on the movement and impacts of invasive alien plants into the EPPO region.

**Existing populations within the EPPO region**

Management measure would be recommended to include an integrated management plan to control existing populations. Monitoring and surveillance including early detection for countries most prone to risk.

NPPO's should facilitate collaboration with all sectors to enable early identification including education measures to promote citizen science and linking with universities, land managers and government departments.

Eradication measures should be promoted where feasible with a planned strategy to include surveillance, containment, treatment and follow-up measures to assess the success of such actions. Regional cooperation is essential to promote phytosanitary measures and information exchange in identification and management methods. Eradication may only be feasible in the initial stages of infestation. Coordination of all stakeholders is required and should be easy to achieve, especially since the distribution is limited.

Natural spread (method of spread within the EPPO region): Increase surveillance in protected areas where there is a high risk the species may invade. Monitor existing populations. NPPO's to provide land managers and stakeholders with identification guides and facilitate regional cooperation, including information on site specific studies of the plant, control techniques and management.

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