ELEMENT STEWARDSHIP ABSTRACT

for

*Microstegium vimineum*

Japanese stilt grass, Nepalese browntop, Chinese packing grass

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THE NATURE CONSERVANCY

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**SCIENTIFIC NAME**

Microstegium vimineum (Trin.) A. Camus

**SYNONYMS**

Andropogon vimineus Trin.
Eulalia viminea (Trin.) Kuntze
Microstegium imberbe (Nees ex Steud.) Tzvelev
Microstegium willdenovianum Nees ex Lindl.
Pollinia imberbis Nees ex Steud.
Pollinia viminea (Trin.) Merr.
Pollinia willdenoviana (Nees ex Lindl.) Benth.

**COMMON NAMES**

Japanese stilt grass, Nepalese browntop, Chinese packing grass

**DESCRIPTION AND DIAGNOSTIC CHARACTERISTICS**

Microstegium vimineum is a shade tolerant, annual C₄ grass (family Poaceae). It is a straggling or decumbent plant, usually 6-10 dm in height, and the reclining stems can grow up to 1.0 m (40 in) long. Its culms (stems) are typically branched, rooting at the lower nodes, and the nodes and internodes are smooth and hairless. The lanceolate leaf blades are 5-8 cm long and 2-15 mm wide, sparsely pubescent on both surfaces, and distinctly tapered at both ends. The ligules are membranous, usually ciliate, and are 0.5-2.0 mm long (Radford et al. 1968).

The terminal or axillary inflorescence is a raceme, 2-7 cm long, with an elongate peduncle and an angled disarticulating rachis. The hirsute fertile spikelets are deciduous, and occur in pairs, with one spikelet sessile and the other pedicellate. The glumes are equal in length (4.5-5.0 mm) and awnless. The first glume is flat and 2-3 veined. The second glume is keeled and 3-veined. There are two lemmas per spikelet, with the lower one sterile and the upper, fertile one awnless or often with a slender awn 4-8 mm. Both cleistogamous (flowers closed at pollination) and chasmogamous (flowers open) conditions have been reported for M. vimineum in Japan, with the axillary flowers all being cleistogamous (Tanaka 1975, in Barden 1987).

The fruit or caryopsis (grain) of M. vimineum is yellowish to reddish, and ellipsoid (2.8-3.0 mm) in shape. Fruiting occurs in September and October in North America (Radford et al. 1968; Hitchcock 1971; Gleason & Cronquist 1991).

M. vimineum can be distinguished from other grasses by its thin, pale green, tapered leaf blades, and by its multiple spikelets that may be either terminal or arising from leaf axils. The alternate leaves have a silvery stripe of reflective hairs down the middle of the upper leaf surface. In the fall, identification becomes somewhat easier after the plant develops a slight purplish tinge (LaFleur 1996; Swearingen 2000).

While M. vimineum is an annual, there has been some confusion regarding whether M. vimineum also occurs as a rhizomatous, perennial (Ehrenfeld 1999; Mehrhoff 2000). According to Mehrhoff (2000), this confusion resulted when specimens of a native perennial, Leersia virginica, were incorrectly identified as M. vimineum. The annual M. vimineum can be distinguished L. virginica (which it frequently grows alongside) by the former’s ciliate leaf sheath collars and paired spikelets (versus L. virginica’s glabrous or pubescent leaf sheaths and 1-flowered spikelets).

**STEWARDSHIP SUMMARY**

M. vimineum is an annual C₄ grass native to Asia from India and Japan. It possesses characteristics typical of many invasive species: it grows quickly, fruits within a single season, produces abundant seed, and easily invades habitats
that have been disturbed by natural (e.g., flood scouring) and anthropogenic (e.g., mowing, tilling) sources. *M. vimineum* was first discovered in the United States in 1919 (Fairbrothers & Gray 1972), and has since spread rapidly to all states east of the Mississippi, and south of and including Connecticut. *M. vimineum* is locally abundant, able to displace native wetland and forest understory vegetation with its dense, expanding monospecific patches. It is usually found under moderate to dense shade in moist conditions, but it does not persist in areas with periodic standing water, nor in full sunlight (Barden 1987, 1991). Once established, the removal of *M. vimineum* requires major eradication and restoration efforts (Bruce et al. 1995).

Manual or mechanical techniques may be the best method for controlling *M. vimineum*, since it is a shallowly-rooted annual. Hand pulling, however, is extremely labor-intensive, is feasible only for small infestations, and will need to be repeated and continued at least seven years to exhaust the seed supply in the seed bank (Virginia Native Plant Society 2000). Mowing or burning early in the season does not control the plant as the plants resprout and new seeds germinate. Following these treatments, plants can still set seed by the end of the season. Mowing may be an effective control method if carried out in late summer, when the plants are in peak bloom but before seed is produced (J. Ehrenfeld, pers. comm.). For extensive infestations, where mechanical methods are not practical, systemic herbicides such as imazameth (tradename Plateau) or glyphosate (tradename RoundUp, or Rodeo in wetland sites), or grass-specific herbicides like sethoxydim (tradenames Vantage or Poast) may be effective (Johnson 1997; Swearingen 2000). No biological controls are currently available for this plant.

**RANGE**

*M. vimineum* was introduced to North America from Asia, where it is native to India, Nepal, China, and Japan. It was first identified in the United States in 1919 in Tennessee, and by 1960 had spread (probably by hay and soil) to Ohio and Pennsylvania, and all Atlantic coastal states from Florida to New Jersey. It was widely used as a packing material for porcelain from China, and this was likely the means of its introduction into the U.S. *M. vimineum* occupies riparian habitats, lawns, woodland thickets, damp fields, and roadside ditches. Reported occurrences of *M. vimineum* in North America currently include: Alabama, Arkansas, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Kentucky, Louisiana, Maryland, Mississippi, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, West Virginia, and Puerto Rico (USDA-NRCS 1999).

**IMPACTS AND THREATS POSED BY MICROSTEGIUM VIMINEUM**

*M. vimineum* is capable of invading wildland areas and swiftly replacing natural communities with nearly monospecific stands. It is generally slow to invade undisturbed areas, but rapidly fills disturbed areas such as flood-scoured stream sides and sewer line rights-of-way that are mowed once a year. An individual plants of *M. vimineum* can produce up to 1000 seeds, and the seeds remain viable in the soil for three to five years. Once established, *M. vimineum* is able to crowd out native herbaceous vegetation in wetlands and forests within three to five years (Hunt 1992; Barden 1987).

*M. vimineum* is a C₄ plant, and C₄ plants are typically adapted to high temperatures and high light regimes. However, unlike most C₄ plants, *M. vimineum* is adapted to low light levels and is able to grow and produce seed in only 5% full sunlight (Winter et al. 1982). Additionally, *M. vimineum* may be responsible for altering natural soil conditions, creating an inhospitable environment for many native species. Kourtev et al. (1998) reported that in areas that have been invaded by *M. vimineum*, both litter and organic soil horizons were thinner than in uninvaded areas, and that the pH of soils in invaded sites was significantly higher than in uninvaded sites. There is no indication that *M. vimineum* produces allelopathic chemicals (Woods 1989).

Established populations of *M. vimineum* usurp quality nesting habitat from quail and other wildlife. In addition, it creates excellent habitat for rats, especially cotton rats (*Sigmodon* spp.), that often prey on the nests of native bobwhite quail and attract other predators as well (A. Houston, pers. comm.).

**HABITAT**

In North America, *M. vimineum* occurs in a variety of disturbed sites. It thrives in along mesic roadsides, ditches, woodland borders, floodplains, and streamsides (Fairbrothers & Gray 1972; Hunt & Zaremba 1992). It can also be
found in mesic upland sites, and is almost always found in moderate to dense shade (Redman 1995). It does not survive, however, in areas with periodic standing water, nor in areas with full sunlight.

**BIOLOGY AND ECOLOGY**

**Light, Moisture, and Temperature**

*M. vimineum* possesses characteristics typical of many invasive species: it grows quickly, fruits within a single season, produces abundant seed, and easily invades naturally (e.g., flood scouring) and artificially (e.g., mowing, tilling) disturbed habitats. Once established, the removal of *M. vimineum* requires major eradication and restoration efforts (Bruce et al. 1995).

*M. vimineum* is unusual in that although it is a C₄ plant, it is adapted to low light conditions (Winter et al. 1982; Barden 1991). It can grow and produce seeds at as little as 5% full sunlight, but maximum growth and seed production occurs at 25-50% full sunlight (Winter et al. 1982; Horton & Neufeld 1998).

Most sites invaded by *M. vimineum* in the United States, have acidic soils (pH 5.8 to 4.8), but some populations are on soils derived from limestone or marble with surficial soil that is neutral or only slightly acidic in reaction. Soils on which *M. vimineum* occurs are typically average in levels of potassium and phosphorus, and high in nitrogen (Redman 1995). The overall acidity of the soils, however, may limit nutrient availability. Soils are usually moist, and are often well-drained silty loams, sandy loams, or loams. Clay was not a significant component of the upper soil horizons in any of the soils invaded by *M. vimineum* at sites studied by Hunt & Zaremba (1992).

No information was found regarding the optimal growing temperatures or the temperature limits of this species. The coldest winter temperature at which invasive populations of *M. vimineum* occur is approximately -21°C to -23°C (Redman 1995).

**Seed Dispersal**

*M. vimineum* fruits and seeds disperse by water, animals, and by humans. (It was originally introduced as packing material or for basket-weaving.) The floating fruits of *M. vimineum* can disperse throughout an entire wetland or alluvial floodplain during high-water events (Woods 1989; Mehrhoff 2000). Even though *M. vimineum* does not exhibit any special adaptations for seed/fruit dispersal such as hooks or barbs, its seeds are small and often adhere to animal fur or clothing. Further, the fruits have been observed being transported on automobiles (Mehrhoff 2000).

*M. vimineum* relies entirely on its seed bank for its annual recruitment. Seeds of *M. vimineum* may need a period of stratification (cool temperatures and high moisture) before they will germinate (Woods 1989). *M. vimineum* seeds stored in the soil may remain viable as long as five years (Barden 1991). *M. vimineum* seeds may have low germination rates (Woods 1989), but many seeds are produced by each plant. Seeds of *M. vimineum* are also able to survive submersion in water for periods of up to 10 weeks. Barden (1991) reports that seeds can germinate while under water, but the plants do not grow. If standing water is removed, more seeds will germinate shortly afterwards.

**ECONOMIC USES**

In the early 1900s, *M. vimineum* was used extensively as a packing material for porcelain, especially fine China porcelain, which may have contributed to its invasion into the United States. Culms of this grass have also been used for basket weaving. *M. vimineum* has not been documented as being intentionally planted as an ornamental, for erosion control, or for forage.

**MANAGEMENT**

**Potential for Restoration of Invaded Sites**
Manual and mechanical, environmental/cultural, and chemical methods are all useful to varying degrees in controlling *M. vimineum*. Prescribed burns have not been successful in controlling this species so far, but fall burns may have the potential for partial control. *M. vimineum* produces a large number of viable seed that can remain in the soil seed bank for seven years or more. If controlled during the early stages of invasion, the potential for successful management is high. The potential for large-scale restoration of wildlands where *M. vimineum* has become established is probably moderate.

**Manual and Mechanical Control**

Hand pulling of *M. vimineum* is the preferred method of removal as it is highly specific and provides minimal impact (except trampling and soil disturbance) to the surrounding environment. Hand pulling is an effective method of control if it is thorough and timed correctly. It is, however, labor-intensive and time-consuming. Pulling late in the season (September-early November) before seed production reduces the unintentional spread of the current year’s seeds. Pulling early in the season (before July), however, allows germination of new plants from the seed bank which will mature during the remaining season and produce seeds. In the northeast, August and late September are good times to pull plants by hand (LaFleur 1996). Yearly weeding is necessary because new plants can appear as a result of seed banking or re-infestation from new seed being dispersed into the area (G. Edinger, letter to J. Randall).

Mowing using a weed whacker (or a weed-eater) is an effective control method if carried out in late summer just before seeds are produced. Mowing at any other time is not useful as the plants have the ability to resprout and can produce seed heads in the axils of their lower leaves (Woods 1989; Barden 1991). Mowing can also be useful in reducing the amount of litter and plant biomass prior to herbicide application, making the herbicide more effective.

**Grazing**

Grazing is not a control option for *M. vimineum* since cattle, deer, and even goats avoid feeding on it (A. Houston, pers. comm.; Barden 1991).

**Flooding**

Flooding for more than three months, or intermittent flooding during the growing season, may be an effective control method for mature plants of *M. vimineum*. The seeds of *M. vimineum*, however, can survive periods of inundation of at least ten weeks (Barden 1991).

**Prescribed Burning**

Spring burns are ineffective at controlling *M. vimineum* because a new cohort of seeds will germinate soon after the burn. Burns in the late fall, however, may be useful in controlling this species (Barden 1991). Burning is also useful in reducing the amount of litter and plant biomass prior to herbicide applications.

**Herbicides**

For large infestations of *M. vimineum*, the use of herbicides may be the only viable option for good control. A series of control experiments using herbicides was carried out at the Ames Plantation (University of Tennessee), and the researchers reported that it is relatively easy to kill *M. vimineum*, but that managing for a desirable plant community is difficult. They found that the herbicide imazameth (tradename Plateau) was the herbicide of choice for controlling *M. vimineum*. This is because imazameth (applied at a rate of 6 ounces per acre) kills *M. vimineum*, but allows the development of (a.k.a., does not kill) the desirable native sedges, ragweeds, and legumes.

The grass-specific herbicide fluazifop-p (tradename Fusilade) applied at the rate of 1.2 liters per hectare (1 pint per acre) also controlled *M. vimineum*, but left a less desirable plant community. Glyphosate (tradename RoundUp) was also tested, but resulted in a complete kill of all plants, which could potentially lead to possible re-invasion by *M. vimineum* or other undesirable species. Barden (1991) also found glyphosate useful in killing *M. vimineum*. Formulations of glyphosate registered for use aquatic systems (Rodeo), has been effective for *M. vimineum* control in wetlands. Woods (1989) in Tennessee found that the grass-specific herbicide sethoxydim (tradenames Poast, Vantage),
applied during late summer at rates of 1 pint per acre, also provided excellent (more than 95%) control of *M. vimineum* and released dicots from competition without injuring them. Pre-emergent herbicides such as diphenamid (tradename Enide) and benefin (tradename Balan) have also demonstrated excellent control of *M. viminimum* seedlings under conditions of good herbicide-to-soil contact (Woods 1989), but do not encourage the germination of native species.

Allan Houston (pers. comm.) reports that if there is a heavy build-up of litter (dead plant material) in *M. vimineum* stands, burning the debris may first be necessary to get adequate herbicide coverage. He suggests applying herbicide when the plants reach a height of 5-10 centimeters (2-4 inches).

**Biological Control**

No biological controls are currently available for *M. vimineum*.

**EXAMPLES OF MICROSTEGIUM VIMINEUM MANAGEMENT ON TNC PRESERVES**

According to TNC’s 1998 Weed Survey, *M. vimineum* has been reported from TNC preserves in New Jersey, North Carolina, Virginia, Georgia, Alabama, Arkansas, Maryland, and in Connecticut. Several preserves reported *M. vimineum* is one of their worst weed problems, but only a few had begun active control measures.

In Maryland, Donnelle Keech reported that burning is not effective in controlling *M. vimineum*. In North Carolina, Robert Merriam reported hand pulling was effective. Elizabeth Farnsworth in Connecticut, however, indicated that hand pulling may be effective in small populations, but seems futile for large populations since it is difficult to eliminate the seed sources. She added that it is important to attack small infestations as soon as possible, and to attack them vigorously!

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**MONITORING**

The distribution of *M. vimineum* should be monitored annually or biannually where there is a threat to protected species. Following all control treatments, further control efforts and monitoring is needed for at least seven years due to the viability of seeds in the seedbank or re-invasion from nearby propagule sources (Barden 1991).
Since *M. vimineum* usually occurs in dense, nearly monospecific stands, permanent line intercepts (or transects) across population borders are an easy technique for periodic monitoring of changes in *M. vimineum* distribution. Where it is less abundant, visual estimates of percent cover changes in permanent plots, or photographic documentation, carried out at the same (phenologic) time each year, may be for monitoring change over time. Additionally, new invasions of *M. vimineum* should be identified as soon as possible, since small populations are the easiest to eradicate.

**Research Needs**

The following research topics need attention: 1) What are the impacts of *M. vimineum* on native communities? 2) What are the mechanisms of *M. vimineum* invasion in a variety of landscapes? 3) Is biological control by inoculation with fungal pathogens a possible control technique? 4) Which species replace *M. vimineum* when control succeeds? And 5) What is the most effective method (for each specific area) of *M. vimineum* control, and how can this method encourage the regeneration of native species?

**REFERENCES**


