2010

FIRST REPORT OF FIELD POPULATIONS OF TWO POTENTIAL APHID PESTS OF THE BIOENERGY CROP *MISCANTHUS × GIGANTEUS*

Jeffrey Bradshaw
University of Nebraska-Lincoln, jbradshaw2@unl.edu

Jarrad R. Prasifka
University of Illinois, prasifka@illinois.edu

Kevin L. Steffey
Dow AgroSciences

Michael E. Gray
University of Illinois at Urbana-Champaign

FIRST REPORT OF FIELD POPULATIONS OF TWO POTENTIAL APHID PESTS OF THE BIOENERGY CROP *MISCANTHUS* × *GIGANTEUS*

JEFFREY D. BRADSHAW[1], JARRAD R. PRASIFKA[1], KEVIN L. STEFFEY[2], AND MICHAEL E. GRAY[3]
[1]Energy Biosciences Institute, University of Illinois, Urbana, IL

[2]Dow AgroSciences, Indianapolis, IN

[3]Department of Crop Sciences, University of Illinois, Urbana, IL

Supplemental material online at http://www.fcla.edu/FlaEnt/fe931.htm#InfoLink2

Sipha flava (Forbes) (yellow sugarcane aphid) and *Rhopalosiphum maidis* (Fitch) (corn leaf aphid) (Hemiptera: Homoptera: Aphididae) are common aphids occurring throughout North America on many host plants, most of which are grasses (Blackman & Eastop 2006). Both aphids are pests of several important food crops, e.g., *Sorghum bicolor* (L.) Moench (sorghum), *Saccharum officinarum* L. (sugarcane), *Triticum* spp. (wheat), and *Zea mays* L. (corn) (Blackman & Eastop 2000). Additionally, both aphids are vectors of potyviruses and *R. maidis* is a vector of luteoviruses in these crops. Until now, to our knowledge, no natural infestations of these aphids have been reported on the grass genus *Miscanthus*.

Miscanthus spp. is a common grass throughout the United States, with ornamental varieties of *M. sinensis* Andersson being the most frequently cultivated species. However, *M.* × *giganteus* Greef and Deuter ex Hodkinson and Renvoize (Liliopsida: Poaceae: Andropogonaeae: Saccharinae) is being evaluated in the United States as a cellulosic feedstock crop (Heaton et al. 2008) primarily to meet production targets for advanced biofuels (e.g., cellulosic ethanol; Energy Independence and Security Act of 2007, 42 U.S.C. § 17001). *Miscanthus* × *giganteus* is a perennial, sterile hybrid (possibly between *M. sinensis* and *M. sacchiflorus* (Maxim.) Hack.) and may exist in nature within a sympatric zone of these 2 species in southeastern Asia (Clifton-Brown et al. 2008).

More than 1,500 insect species reportedly feed on *Saccharum officinarum* (sugarcane) (Long & Hensley 1972), a sister genus of *M.* × *giganteus* (Hodkinson et al. 2002); however, very few insects have been reported to feed on *M.* × *giganteus* (Prasifka et al. 2009). The lack of reported insect herbivory on *M.* × *giganteus* may be related to few extensive survey efforts. However, in a 3-year intensive survey of invertebrates of *M.* × *giganteus* in the United Kindom, Semere & Slater (2007) found "no major pests." A similar 2-year survey in Germany noted 1 arthropod pest, *Tetranychus urticae* Koch (twospottted spider mite), a polyphagous, widespread species that causes damage during dry and hot weather (Gottwald & Adam 1998). The only documentation of an aphid feeding on *M.* × *giganteus* is from a laboratory study of aphid transmission of *Barley yellow dwarf virus* (BYDV) (Huggett et al. 1999); however, they suggest that the genus *Miscanthus* is "nutritionally insufficient" for aphids.

Visual observations and samples were taken from managed *M.* × *giganteus* plots from locations in Illinois, Indiana, Kentucky, and Nebraska in 2008. Samples were collected by hand or by vacuum sampler, (Burd & Porter 2009), and transported to the laboratory for species confirmation.

Sipha flava was collected from 7 locations from 4 states in 2008 (Table 1) and was found on the lower leaves of both young and old plants, from 1- to 21-year old plantings (Fig. 1A). Some populations appeared to be large enough to cause leaf death (Fig. 1B). Generally, leaves infested with *S. flava* were yellow to reddish in color; similar symptoms have been noted in sugarcane (Nuessly 2005) and sorghum (Costa-Arbulú et al. 2001). Ants, *Crematogaster cerasi* (Fitch), were observed tending *S. flava* on 14 Jul 2008 in Champaign, IL, and similar tending activity was observed elsewhere throughout Illinois.

Rhopalosiphum maidis, collected from 4 locations from 4 states (Table 1), was found only within the whorls of young *M.* × *giganteus* in first-year plantings (Fig. 1C, white arrow). In Champaign, IL, *R.* maidis populations occasionally co-infested *M.* × *giganteus* tillers with other recently-identified *M.* × *giganteus* herbivores, e.g., *Spodoptera frugiperda* (J. E. Smith), (Prasifka et al. 2009) (Fig. 1C, black arrow). No conspicuous symptoms were associated with these infestations; however, very young tillers (4-6 expanded leaves) showed some yellowing of uppermost leaves.

Multistate agronomic trials of *M.* × *giganteus* (as well as other bioenergy feedstock grasses) are underway in the United States with a renewed interest in both economically and environmentally sustainable energy production. Crops attacked by *S. flava* and *R. maidis* contributed to more than $6.4 billion of the 2007 U.S. sugar and grain production value (about 4% of the 2007 total U.S. crop production value) (USDA 2009).

The broader purpose of this survey was to sample for common insect herbivores from known field establishments of *M.* × *giganteus* in North America. Twenty-one aphids are known to use *Miscanthus* (mostly *M. sinensis*) as a host; therefore, there is potential for aphid damage on *M.* × *giganteus*. This damage potential is especially

TABLE 1. LOCATION, COLLECTION DATE, CROP STAND SIZE, AND CROP AGE FOR *SIPHA FLAVA* AND *RHOPALOSIPHUM MAIDIS* COLLECTED IN 2008 FROM *MISCANTHUS* × *GIGANTEUS*.

Location	Coordinate (latitude/longitude)	Altitude (m)	Date	Species collected		Stand	
				S. flava	*R. maidis*	size (ha)	age (years)
Mead, NE	N41°10.42' W96°27.92'	360	26-Aug	X	X	0.1	<1
Lexington, KY	N38°07.77' W84°30.15'	275	9-Sep	X	X	0.1	<1
West Lafayette, IN	N40°26.52' W86°55.85'	192	9-Sep	X	X	0.1	<1
Champaign, IL	N40°05.38' W88°13.02'	757	20-Aug	X	X	2.1	2
Fairfield, IL	N38°22.86' W88°23.40'	136	9-Jul	X	—	<0.1	6
Brownstown, IL	N38°57.05' W88°57.56'	182	30-Jul	X	—	<0.1	6
Champaign, IL	N40°06.39' W88°12.25'	742	14-Jul	X	—	<0.1	21

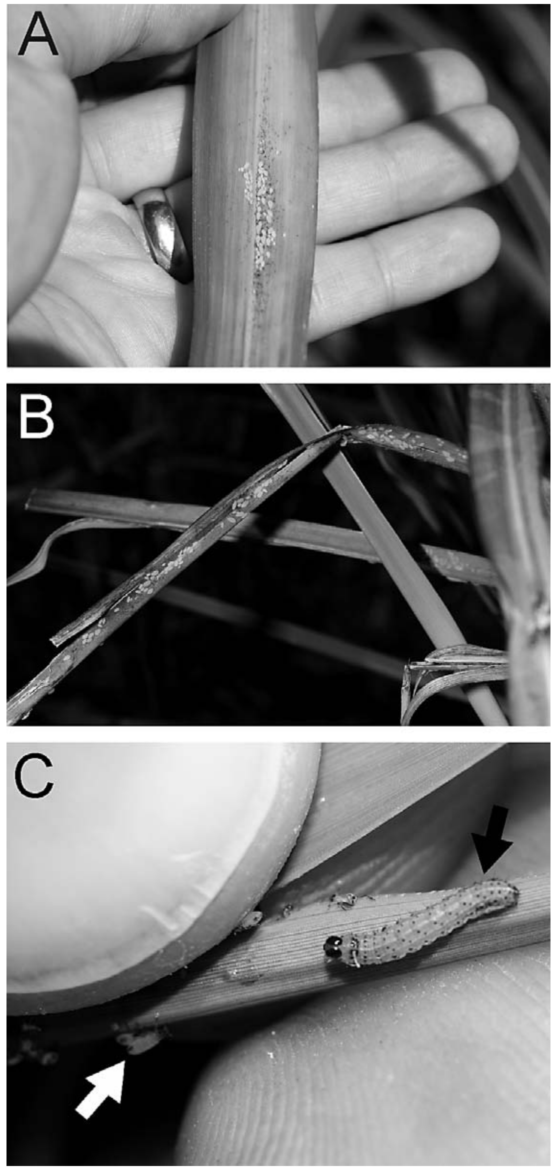

Fig. 1. (A) A small *Sipha flava* colony on the underside of a *Miscanthus* × *giganteus* leaf with associated red stippling and yellowing symptoms of the leaf, Brownstown, IL. (B) Leaf death indicative of a large *Sipha flava* infestation, Mead, NE. (C) *Rhopalosiphum maidis* colony (white arrow) and a larval *Spodoptera frugiperda* (black arrow) co-infesting the terminal whorl of a *Miscanthus* × *gigantues* tiller, Champaign, IL.

concerning because most plant viruses are transmitted by aphids (Hull 2002) and *R. maidis* can transmit the RPV strain of BYDV to *M.* × *giganteus* (Huggett et al. 1999). However, expectations for sampling potential pests of *M.* × *giganteus* were reduced because of repeated references indicating that none should be found (e.g., Semere & Slater 2007; Atkinson 2009).

Captures of alate *S. flava* occur about 14 d earlier in the growing season than captures of alate *R. maidis* (David Voegtlin, unpublished data); however, infestations of *S. flava* are likely to occur even earlier, relative to *R. maidis*, because *S. flava* overwinter in northern latitudes. Such infestations of *S. flava* in *M.* × *giganteus* appear to have the potential to damage young plants, similar to infestations of *S. flava* in other crops (Long & Hensley 1972; Starks & Mirkes 1979; Breen & Teetes 1990). Indeed all of the surveyed plots, including young, small stands (Table 1), were infested with *S. flava*. Therefore, since aphids can locate these small plots of *M.* × *giganteus*, they inevitably will find larger, commercial-scale fields as well. Broadly speaking, this may result in a need for insect management decisions for this bioenergy feedstock and related crops; potentially resulting in a reevaluation of the input costs for economical bioenergy-crop production.

Summary

Miscanthus × *giganteus* Greef and Deuter ex Hodkinson and Renvoize is being evaluated as a cellulosic feedstock for energy production in the United States. This is the first field report of *Sipha flava* (Forbes) and *Rhopalosiphum maidis* (Fitch) (Hemiptera: Homoptera: Aphididae) on *M.* × *giganteus* and the first report of these aphids on *Miscanthus* in the Western Hemisphere. A qualitative survey of managed *M.* × *giganteus* stands revealed *S. flava* or *R. maidis* populations at 7 sample locations in 4 states. The large populations of *S. flava* observed on young stands of *M.* × *giganteus* suggests their potential for economic importance.

Acknowledgments

We thank David Voegtlin and Doris Lagos, University of Illinois Natural History Survey, for helpful discussion and aphid identification. We thank Dr. Gregory Evans and one anonymous reviewer for their constructive comments. Additionally, we are grateful to Tom Voigt, Energy Biosciences Institute, University of Illinois, for assistance in locating *M.* × *giganteus* plots.

References Cited

Atkinson, C. J. 2009. Establishing perennial grass energy crops in the UK: A review of current propagation options for *Miscanthus*. Biomass Bioenergy. 33: 752-759.

Blackman, R. L., and Eastop, V. F. 2000. Aphids on the World's Crops: An Identification and Information Guide. John Wiley & Sons Ltd., London. 466 pp.

Blackman, R. L., and Eastop, V. F. 2006. Aphids on the World's Herbaceous Plants and Shrubs. John Wiley & Sons Ltd., London. 1439 pp.

Breen, J. P., and Teetes, G. L. 1990. Economic injury levels for yellow sugarcane aphid (Homoptera: Aphididae) on seedling sorghum. J. Econ. Entomol. 83: 1008-1014.

Burd, J. D., and Porter, D. R. 2009. Biotypic diversity in greenbug (Hemiptera: Aphididae): characterizing new virulence and host associations. J. Econ. Entomol. 99: 959-965.

Clifton-Brown, J., Chiang, Y., and Hodkinson, T. 2008. *Miscanthus*: genetic resources and breeding potential to enhance bioenergy production, pp. 273-294 *In* W. Vermerris [ed.], Genetic Improvement of Bioenergy Crops. Springer Science+Business Media LLC. N. Y. 450 pp.

Costa-Arbulú, C., Gianoli, E., Gonzáles, W. L., and Niemyer, H. M. 2001. Feeding by the aphid *Sipha flava* produces a reddish spot on leaves of *Sorghum halepense*: an induced defense. J. Chem. Ecol. 27: 273-283.

Gottwald, R., and Adam, L. 1998. Ergebnisse zu entomologischen erhebungen und zur unkrautbekamprung bei *Miscanthus* und anderen C4-pflanzen. Arch. Phytopathol. Plant Prot. 31: 377-386.

Heaton, E. A., Dohleman, F. G., and Long, S. P. 2008. Meeting US biofuel goals with less land: the potential of *Miscanthus*. Global Change Biol. 14: 2000-2014.

Hodkinson, T., Chase, M., Lledó, D., Salamin, N., and Renoize, S. 2002. Phylogenetics of *Miscanthus*, *Saccharum* and related genera (Saccharinae, Andropogoneae, Poaceae) based on DNA sequences from ITS nuclear ribosomal DNA and plastid *trnL* intron and *trnL-F* intergenic spacers. J. Plant Res. 115: 381-392.

Huggett, D. A. J., Leather, S. R., and Walters, K. F. A. 1999. Suitability of the biomass crop *Miscanthus sinensis* as a host for the aphids *Rhopalosiphum padi* (L.) and *Rhopalosiphum maidis* (F.), and its susceptibility to the plant luteovirus *Barley yellow dwarf virus*. Agric. For. Entomol. 1: 143-149.

Hull, R. 2002. Matthews' Plant Virology. Academic Press, London. 1001 pp.

Long, W. H., and Hensley, S. D. 1972. Insect pests of sugar cane. Annu. Rev. Entomol. 17: 149-176.

Nuessly, G. S. 2005. Yellow sugarcane aphid, *Sipha flava* (Forbes) (Insecta: Hemiptera: Aphididae). Featured creatures, EENY-354, Available online: entnemdept.ufl.edu/creatures/field/bugs/yellow_sugarcane_aphid.htm.

Prasifka, J. R., Bradshaw, J. D., Meagher, R. L., Nagoshi, R., Steffey, K. L., and Gray, M. E. 2009. Development and feeding of fall armyworm on *Miscanthus* × *giganteus* and switchgrass. J. Econ. Entomol. 102: 2154-2159.

Semere, T., and Slater, F. 2007. Invertebrate populations in miscanthus (*Miscanthus* × *giganteus*) and reed canary-grass (*Phalaris arundinacea*) fields. Biomass Bioenergy. 31: 30-39.

Starks, K., and Mirkes, K. 1979. Yellow sugarcane aphid (Homoptera, Aphididae)—plant-resistance in cereal crops. J. Econ. Entomol. 72: 486-488.

[USDA] United States Department of Agriculture. 2009. Crop values 2008 summary. National Agricultural Statistics Service, February 2009.