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TRAPPING *MOCIS* SPP. (LEPIDOPTERA: NOCTUIDAE) ADULTS WITH DIFFERENT ATTRACTANTS

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ABSTRACT

Experiments conducted in a pasture agroecosystem in central Florida showed that two-component lures composed of acetic acid and 3-methyl-1-butanol placed in Unitraps collected adults of three species of grass looper: *Mocis disseverans* (Walker), *M. latipes* (Guenée), and *M. marcida* (Guenée) males and females were collected from July through November, with peaks from late September through late October. Other noctuid moths also were captured, but constituted less than 33% of the total moths collected. In 2001 and 2002, 67.7 and 72.4% of the *Mocis* spp. moths collected were females, respectively. Phenylacetaldehyde-baited traps collected fewer *Mocis* spp. moths. The trapping system suggested by our results will aid growers in monitoring for a pest complex that lacks commercially-available sex pheromone lures.

Key Words: *Mocis latipes*, *Mocis disseverans*, *Mocis marcida*, acetic acid, 3-methyl-1-butanol, grass loopers

RESUMEN

Experimentos realizados en un agro-ecosistema de pastos en la parte central de Florida mostraron que los atrayentes de dos componentes compuestos de ácido acético y 3-metil-1-butanol puestos en trampas (Unitraps) recolectaron adultos de tres especies de gusanos medidores. Machos y hembras de *Mocis disseverans* (Walker), *M. latipes* (Guenée), y *M. marcida* (Guenée) fueron recolectados de julio a noviembre, con picos de población desde la última semanal de septiembre hasta la última semana de octubre. Otras mariposas noctuidas también fueron recolectadas, pero constituyeron menos de 33% del total de las palomillas recolectadas. En 2001 y 2002, 67.7 y 72.4% de las palomillas de *Mocis* spp. recolectadas fueron hembras, respectivamente. Las trampas cebadas con fenilacetatoaldehído recolectaron menos especímenes de *Mocis* spp. El sistema de trampa sugerido por nuestros resultados ayudara a los agricultores en el monitoreo para un complejo de plagas que no dispone señuelos de feromonas sexuales comercialmente disponibles.

Moths in the genus *Mocis* (*disseverans* (Walker), *latipes* (Guenée), *marcida* (Guenée), and *texana* (Morrison)) are commonly called grass loopers or striped grass loopers. *Mocis* spp. larvae are important pests in the southeastern United States of forage and pasture grasses (Watson 1933; Ogunwolu & Habeck 1975; Koehler et al. 1977) and turf grasses (Reinert 1975), but also may infest and damage maize (Vickery 1924), rice, sorghum (Genung 1964, 1967, 1968), and sugarcane (Vickery 1924; Hall 1985). They also are important pests in Central America, South America, and the Caribbean, damaging both pastures grasses and cultivated grasses (Gibbs 1990; Portillo et al. 1991; Cave 1992).

Life history, biology, and geographic information for *Mocis* spp. have been hampered by misuse of scientific names in the literature and misidentification in the field. For instance, *M. latipes* has been recorded as *Remigia repanda* (F.) (a true species known from the Caribbean), *R. latipes* (Guenée),

and *M. repanda* (F.) (Dean 1985), and adults can be confused with velvetbean caterpillar, *Anticarsia gemmatilis* Hübner, a species belonging to the same subfamily (Catocalinae) that shares similar external morphology (Gregory et al. 1988).

Several sex pheromone components have been identified for *Mocis* spp. Field testing of both wire cone and bucket-style traps baited with a 2:98 load ratio of (Z,Z,Z)-3,6,9-eicosatriene (Z)-(3,6,9)-C20 and (Z,Z,Z)-3,6,9-heneicosatriene (Z)-(3,6,9)-C21 or just (Z)-(3,6,9)-C21 caught male *M. disseverans* (Landolt et al. 1986; McLaughlin & Heath 1989). *Mocis latipes* responded best to a 20:80 ratio of (Z,Z)-6,9-heneicosadiene (Z)-(6,9)-C21 and (Z)-(3,6,9)-C21 (Landolt & Heath 1989). Growers and consultants have been unable to monitor adult *Mocis* spp. with these components in baited traps because these chemicals are expensive to synthesize and are not commercially available.

Mocis latipes and *M. disseverans* moths were collected in traps baited with aged solutions of

molasses and jaggery (unrefined palm sugar) (Landolt 1995). Headspace collections of chemicals identified from fermented molasses solutions included acetic acid and isobutanol (2-methyl-1-propanol). These compounds, along with another short-chain alcohol (3-methyl-1-butanol), were tested as baits for vespid wasps (Landolt 1998; Landolt et al. 2000). During testing large numbers of noctuid moths were also collected. Further testing with wet and dry traps and varying amounts of acetic acid plus 3-methyl-1-butanol collected both sexes of the noctuids *Lacanobia subjuncta* (Grote & Robinson), *Mamestra configurata* Walker, *Xestia c-nigrum* (L.), and *Pseudaletia unipuncta* (Haworth) (Landolt 2000; Landolt & Hammond 2001; Landolt & Alfaro 2001; Landolt & Higbee 2002). Another compound, phenylacetaldehyde, has been successful in trapping *Mocis* spp. adults (Meagher 2001, 2002). Since monitoring of *Mocis* spp. is not possible at this time with sex pheromones as lures, our experiments were conducted to determine if acetic acid, 3-methyl-1-butanol, or phenylacetaldehyde can be used to attract adults.

MATERIALS AND METHODS

Field Site and Moth Trapping

The experiments were conducted at the University of Florida, Range Cattle Research and Education Center, Ona (27°25', 81°55'; 26 m elevation). This center contains over 1150 hectares of natural and improved grasses. *Mocis* spp. moths were collected in Standard Universal Moth Traps, 'Unitraps' (Great Lakes IPM, Vestaburg, MI) that were placed on 1.5-m metal poles along roads and pasture edges. Traps containing a treatment were placed at least 30 m apart, and trap order was randomized at each sample date. All traps contained insecticide strips to kill moths that were captured (Hercon® Vaportape II containing 10% 2, 2-dichlorovinyl dimethyl phosphate, Hercon Environmental Co., Emigsville, PA). Trap contents were removed weekly or every two weeks, depending on weather conditions. Moths were placed in plastic bags and returned to the laboratory for identification. Since sample intervals were variable, moth numbers were counted and divided by the number of nights the traps were active between sample dates.

Traps were baited with the chemicals acetic acid, 3-methyl-1-butanol, and phenylacetaldehyde (Aldrich Chemical Co., Milwaukee, WI). Acetic acid and 3-methyl-1-butanol as two-component lures were loaded on cotton balls in 8-ml polypropylene vials (Nalgene 2006-9025, Fisher, Pittsburgh, PA). These controlled release dispensers were placed on the bottom of the bucket portion of the Unitraps and were secured by small pieces of PVC pipe glued to the bucket. Attaching

vial tops with holes of different diameters modified chemical release rate (Landolt & Alfaro 2001). Phenylacetaldehyde was dispensed either in vials (as above) or in hollow polyethylene stoppers (Kimble, Vineland, NJ, purchased through Thomas Scientific, Swedesboro, NJ, #9713-F28) (Meagher 2001, 2002).

Experiments in 2001

Two separate experiments were conducted. Traps for Experiment 1 were placed 19 June and removed 29 November. The experiment was designed as a randomized complete block with three replications of four treatments: (1) acetic acid and 3-methyl-1-butanol released in separate vials with tops of 3.2 mm-hole diameters, (2) phenylacetaldehyde released in vials with tops of 3.2 mm-hole diameters, (3) phenylacetaldehyde loaded into stoppers (0.5 ml) and placed at the top of the traps (Meagher 2001), and (4) unbaited traps. Lures were changed 28 June, 19 July, 15 August, 30 August, 11 September, 27 September, 11 October, 26 October, and 7 November. Moths were removed from traps on 19 separate dates. *Mocis* moths were separated by sex but were not identified to species. Analysis of variance (PROC MIXED, Contrasts, Littell et al. 1996) was used to examine variation among treatments.

Traps for the second experiment were placed 26 October and removed 29 November. The experiment was designed as a randomized complete block with four replications (sample date) of six treatments: (1) acetic acid and 3-methyl-1-butanol released from separate vials with top diameter holes of 1.6 mm, (2) 3.2 mm, or (3) 6.4 mm, (4) phenylacetaldehyde released from vials with a top diameter hole of 6.4 mm or (5) in vials without tops, and (6) unbaited traps. Lures were changed 7 November. Moths were extracted from traps on 4 separate dates. *Mocis* moths were separated by sex but were not identified to species. Analysis of variance (PROC MIXED, Contrasts, Littell et al. 1996) was used to examine variation among treatments.

Experiments in 2002

Three separate experiments were conducted in 2002. Traps for each experiment were placed 19 July and removed 7 November. Each experiment was designed as a randomized complete block with twelve replications (sample date) of the treatments. Lures were replaced 1 August, 29 August, 11 September, 26 September, and 24 October. *Mocis* species were determined from genitalia descriptions in Gregory et al. (1988). Moths were separated by sex and females were dissected to determine mating status. Analysis of variance (PROC MIXED, Contrasts, Littell et al. 1996) was used to examine variation among treatments.

The first experiment compared capture of moths in treatments of acetic acid and 3-methyl-1-butanol in separate vials with top diameter holes of 1.6 mm, 3.2 mm, or 6.4 mm. The second and third experiments compared capture of moths in treatments where one component was released at a constant level while the other component was not released (= 0) or released at varying levels. Experiment 2 contained treatments consisting of acetic acid released from vials with top diameter holes of 3.2 mm, while 3-methyl-1-butanol was released from 1.6, 3.2, or 6.4 mm diameter holes. Experiment 3 contained treatments with 3-methyl-1-butanol released from vials with 3.2 mm diameter holes, while acetic acid was released from 1.6, 3.2, or 6.4 mm diameter holes. In each experiment, there was an additional treatment of phenylacetaldehyde loaded into stoppers and a treatment that contained empty vials (control).

RESULTS

2001 Captures

Over 1300 *Mocis* spp. male ($n = 431$) and female ($n = 904$) moths were collected from late June through late November in traps baited either with acetic acid + 3-methyl-1-butanol or phenylacetaldehyde (Fig. 1). Significantly fewer moths were collected in traps with no lures than in traps with either the combination lure of acetic acid + 3-methyl-1-butanol or traps baited with phenylacetaldehyde (total moths = 28 vs. 780 vs. 555, respectively, $P < 0.05$; Table 1). More female moths per night were captured than male moths in traps baited with an attractant (0.74 ± 0.12 vs. 0.36 ± 0.05 , respectively; $P = 0.0014$).

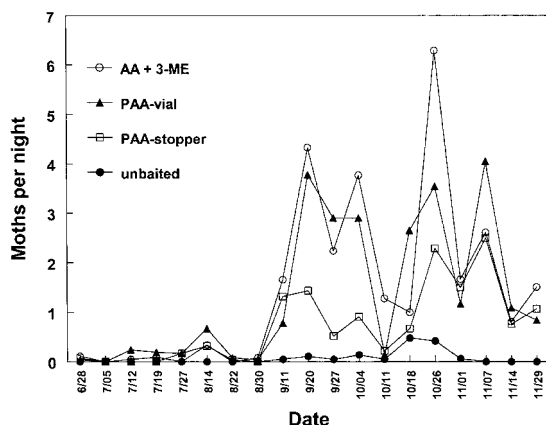


Fig. 1. Mean number of *Mocis* spp. moths collected per night in traps baited with acetic acid (AA) + 3-methyl-1-butanol (3-ME), phenylacetaldehyde (PAA) in vials, phenylacetaldehyde in stoppers, or in unbaited traps, Ona, FL, 2001.

Almost 400 *Mocis* spp. moths were collected in attractant-baited traps during November in Experiment 2. Fewer male *Mocis* moths were collected in traps baited with phenylacetaldehyde or in traps baited with acetic acid + 3-methyl-1-butanol from vials with 1.6 mm diameter holes (Table 2). There was no difference in trap capture among the attractants for female *Mocis* moths. No moths were collected in the control traps. As in Experiment 1, more female moths were captured per night than male moths in traps baited with an attractant (0.88 ± 0.14 vs. 0.45 ± 0.08 , respectively; $P = 0.0107$).

Several other noctuid species were collected in both experiments, including *Platysenta mobilis* (Walker), *Spodoptera dolichos* (F.), *S. eridania* (Cramer), *S. exigua* (Hübner), *S. frugiperda* (J. E. Smith), *S. latifascia* (Walker), *S. ornithogalli* (Guenée) (Amphipyrae); *A. gemmatalis* (Catalinae); *Leucania* spp., *Pseudaletia unipuncta* (Haworth) (Hadeninae); *Agrotis subterranea* (F.), *Anicla infecta* (Ochsenheimer) (Noctuinae); *Agrapha oxygramma* (Geyer), *Argyrogramma verruca* (F.), and *P. includens* (Plutinae). These species comprised 26% (469/1804) of total moths captured in Experiment 1 and 37.4% (147/393) of moths captured in Experiment 2.

2002 Captures

Totals of 265 *M. disseverans*, 192 *M. latipes*, and 46 *M. marcida* moths were collected from July through November in traps baited individually with acetic acid or 3-methyl-1-butanol, or a combination lure (Fig. 2). Females comprised 72.6% of the moths collected and 89.6% of them contained a spermatophore (moths per night: females 0.077 ± 0.009 > males 0.033 ± 0.004 > virgin females 0.008 ± 0.002 ; $P < 0.001$). Traps baited with phenylacetaldehyde collected only 42 moths.

There was no difference within a species in numbers of *M. disseverans* or *M. latipes* collected in traps baited with the two-component lure released from vials with holes in their tops ranging from 1.6 mm to 6.4 mm (Experiment 1, Table 3). Traps baited with phenylacetaldehyde collected significantly fewer numbers of moths. In Experiment 2, where 3-methyl-1-butanol was released with varying rates, there was a trend for traps to contain fewer moths when only acetic acid was released (Table 4). There were no differences in trap captures among the other 3-methyl-1-butanol release rates for either *M. disseverans* or *M. latipes*. Higher numbers of moths were collected in the experiment in which acetic acid release rates varied. In Experiment 3, traps releasing only 3-methyl-1-butanol collected fewer *M. disseverans* and tended to collect fewer *M. latipes* (Table 5). Differences among the varied release rates of acetic acid were not different for either species. In all experiments during 2002, traps sampled in Septem-

TABLE 1. COLLECTION OF *MOCIS* SPP. MOTHS PER NIGHT IN UNITRAPS BAITED WITH ACETIC ACID + 3-METHYL-1-BUTANOL (AA + 3-ME), PHENYLACETALDEHYDE (PAA) DISPENSED FROM A VIAL OR STOPPER, OR IN UNBAITED TRAPS, EXPERIMENT 1, ONA, FL, 2001.

Lure	<i>Mocis</i> males	<i>Mocis</i> females	Total <i>Mocis</i>
AA + 3-ME	0.48 ± 0.11 a	0.88 ± 0.27 a	1.36 ± 0.37 a
PAA-vial	0.38 ± 0.08 a	0.83 ± 0.24 a	1.22 ± 0.30 a
PAA-stopper	0.23 ± 0.04 a	0.49 ± 0.09 a	0.72 ± 0.13 ab
Unbaited	0.04 ± 0.01 b	0.03 ± 0.02 b	0.07 ± 0.03 b

Means within a column with the same letter are not significantly different, *P* > 0.05.

ber and October collected the most moths. As in 2001, many other noctuid species were collected, comprising 32.2, 17.0, and 16.2% of all moths for Experiment 1, 2 and 3, respectively.

DISCUSSION

Most research conducted with *Mocis* spp. in Florida has been concentrated in the north-central area. In this region, *M. marcid*a abundance peaked in late July to early August, while *M. latipes* and *M. disseverans* densities were highest in late September and early October (Ogunwolu & Habeck 1975). Our results found higher numbers of all three species from late September through late October in south-central Florida.

Dean (1985) showed that *M. latipes* was the species that was most economically important in forage grasses, but our traps collected higher numbers of *M. disseverans* than *M. latipes* or *M. marcid*a. It is possible that *M. disseverans* moths are more attracted to our lures than the other species. It is also uncertain whether *M. disseverans* larvae have a higher incidence or are more damaging to cultivated forage grasses grown for

cattle. Larval identification among species is difficult, especially between *M. latipes* and *M. disseverans*, and between *M. marcid*a and *M. texana* (Ogunwolu & Habeck 1979). Future research should document the relative abundance of these species based on larval sampling.

The two types of lures tested compared attractiveness to two different natural sources. Acetic acid and short-chain alcohols similar to 3-methyl-1-butanol have been isolated from fermenting solutions of molasses and other sugar-containing materials which have been used as attractants for tortricid and noctuid moths (Frost 1926; Ditman & Cory 1933; Norris 1935; Landolt 1995; Landolt & Mitchell 1997). Phenylacetaldehyde has been isolated from flowering plants and shrubs including *Zea mays* L. (Poaceae) (Cantelo & Jacobson 1978), *Araujia sericofera* Brothero (Asclepiadaceae) (Cantelo & Jacobson 1979), *Abelia grandiflora* (André) (Caprifoliaceae) (Haynes et al. 1991), *Cestrum nocturnum* (L.) (Solanaceae) (Heath et al. 1992), and *Gaura* spp. (Onagraceae) (Shaver et al. 1997). It has also been identified as one of the compounds responsible for the male scent of a papilionid butterfly (Honda 1980).

Phenylacetaldehyde attracted moths in 2001 but was not an effective lure in 2002. The material used in 2002 was from the same bottle used in 2001. This chemical is known to be unstable (Brown 1975) and may have polymerized to a form that is not as attractive to moths.

Mocis latipes and *M. disseverans* were previously collected in Florida in traps baited with molasses or jaggery (Landolt 1995). The use of acetic acid and 3-methyl-1-butanol as lure combinations in the Pacific Northwest captured many noctuid species from several subfamilies, but *Mocis* spp. are not found in Washington and they were not collected (Landolt & Hammond 2001). Release rate experiments showed that more moths were collected when acetic acid was released from vials with holes 3.0 mm in diameter and 3-methyl-1-butanol released from vials with hole diameters ≤3.0 mm (Landolt & Alfaro 2001; Landolt & Higbee 2002). Our results also showed that releasing both chemicals with vial holes of 3.2 mm was effective. The single component lures were not as effective at collecting *Mocis* moths.

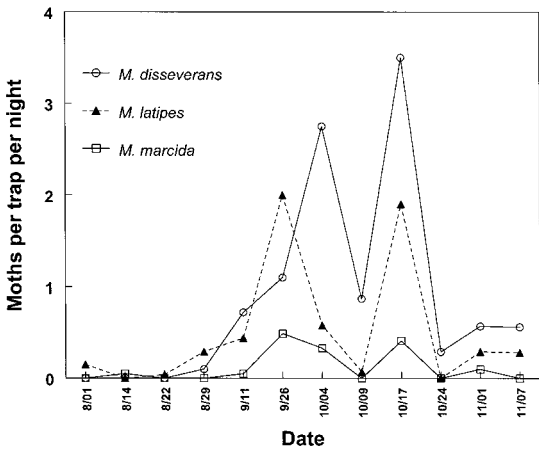


Fig. 2. Mean number of three species of *Mocis* collected per night in experiments with acetic acid and 3-methyl-1-butanol as two-components lures in baited traps, Ona, FL, 2002.

TABLE 2. COLLECTION OF *MOCIS* SPP. MOTHS PER NIGHT IN UNITRAPS BAITED WITH ACETIC ACID + 3-METHYL-1-BUTANOL (AA + 3-ME) RELEASED FROM VIALS WITH 6.4-, 3.2-, OR 1.6-MM OPENINGS, PHENYLACETALDEHYDE (PAA) DISPENSED FROM A VIAL WITH A 6.4-MM OPENING OR FROM A VIAL WITH NO TOP, OR IN UNBAITED TRAPS, EXPERIMENT 2, ONA, FL, 2001.

Lure	<i>Mocis</i> males	<i>Mocis</i> females	Total <i>Mocis</i>
AA + 3-ME (6.4)	0.61 ± 0.12 ab	0.58 ± 0.20 ab	1.19 ± 0.12 a
AA + 3-ME (3.2)	0.82 ± 0.22 a	0.98 ± 0.36 a	1.81 ± 0.51 a
AA + 3-ME (1.6)	0.19 ± 0.14 c	0.85 ± 0.17 ab	1.04 ± 0.30 ab
PAA (6.4)	0.32 ± 0.07 bc	0.82 ± 0.25 ab	1.14 ± 0.28 a
PAA-no top	0.29 ± 0.17 bc	1.14 ± 0.53 a	1.43 ± 0.63 a
Unbaited	0.0 ± 0.00 c	0.0 ± 0.0 b	0.0 ± 0.0 b

Means within a column with the same letter are not significantly different, $P > 0.05$.

TABLE 3. COLLECTION OF *MOCIS DISSEVERANS* AND *M. LATIPES* MOTHS PER NIGHT IN UNITRAPS BAITED WITH ACETIC ACID + 3-METHYL-1-BUTANOL (AA + 3-ME) WITH 1.6-, 3.2-, OR 6.4-MM HOLES, EXPERIMENT 1, ONA, FL, 2002. TRAPS ALSO WERE BAITED WITH PHENYLACETALDEHYDE (PAA) AND THERE WERE UNBAITED TRAPS.

Lure	<i>M. disseverans</i>	<i>M. latipes</i>
AA + 3-ME (6.4)	0.22 ± 0.11 ab	0.23 ± 0.09 a
AA + 3-ME (3.2)	0.35 ± 0.15 a	0.10 ± 0.05 ab
AA + 3-ME (1.6)	0.40 ± 0.18 a	0.17 ± 0.07 ab
PAA	0.03 ± 0.02 b	0.03 ± 0.02 b
Unbaited	0.0 ± 0.0 b	0.0 ± 0.0 b

Means within a column with the same letter are not significantly different, $P > 0.05$.

TABLE 4. COLLECTION OF *MOCIS DISSEVERANS* AND *M. LATIPES* MOTHS PER NIGHT IN UNITRAPS BAITED WITH ACETIC ACID (AA) RELEASED WITH 3.2-MM HOLES AND 3-METHYL-1-BUTANOL (3-ME) RELEASED WITH VARYING HOLE SIZES, EXPERIMENT 2, ONA, FL, 2002. TRAPS ALSO WERE BAITED WITH PHENYLACETALDEHYDE (PAA) AND THERE WERE UNBAITED TRAPS.

Lure	<i>M. disseverans</i>	<i>M. latipes</i>
AA (3.2) + 3-ME (6.4)	0.29 ± 0.17 a	0.12 ± 0.06 ab
AA (3.2) + 3-ME (3.2)	0.30 ± 0.12 a	0.09 ± 0.06 abc
AA (3.2) + 3-ME (1.6)	0.26 ± 0.13 a	0.17 ± 0.07 a
AA (3.2)	0.08 ± 0.06 ab	0.03 ± 0.03 bc
PAA	0.04 ± 0.02 b	0.07 ± 0.04 abc
Unbaited	0.0 ± 0.0 b	0.0 ± 0.0 c

Means within a column with the same letter are not significantly different, $P > 0.05$.

TABLE 5. COLLECTION OF *MOCIS DISSEVERANS* AND *M. LATIPES* MOTHS PER NIGHT IN UNITRAPS BAITED WITH 3-METHYL-1-BUTANOL (3-ME) RELEASED WITH 3.2-MM HOLES AND ACETIC ACID (AA) RELEASED WITH VARYING HOLE SIZES, EXPERIMENT 3, ONA, FL, 2002. TRAPS ALSO WERE BAITED WITH PHENYLACETALDEHYDE (PAA) AND THERE WERE UNBAITED TRAPS.

Lure	<i>M. disseverans</i>	<i>M. latipes</i>
AA (6.4) + 3-ME (3.2)	0.50 ± 0.14 a	0.55 ± 0.28 a
AA (3.2) + 3-ME (3.2)	0.30 ± 0.11 ab	0.21 ± 0.11 b
AA (1.6) + 3-ME (3.2)	0.31 ± 0.10 ab	0.23 ± 0.11 ab
3-ME (3.2)	0.01 ± 0.01 c	0.02 ± 0.02 b
PAA	0.10 ± 0.05 bc	0.12 ± 0.04 b
Unbaited	0.03 ± 0.02 c	0.04 ± 0.03 b

Means within a column with the same letter are not significantly different, $P > 0.05$.

The lack of a commercially-available pheromone hampers growers' efforts to monitor these pests. However, sugar-product lures have an advantage over pheromone lures in that they attract both males and females (Landolt & Alfaro 2001; Landolt & Higbee 2002). Adult trapping has been successful in pasture agroecosystems as an early warning management prediction tool with fall armyworm (*S. frugiperda*) (Silvain & Ti-A-Hing 1985; Silvain 1986). The research reported here suggests that two-component lures composed of acetic acid and 3-methyl-1-butanol were successful in capturing three *Mocis* species. These moths are comparatively large and should be identifiable by trained growers or consultants when the moths are captured in traps baited by floral volatile lures. Future research should determine if there is a relationship between collection of larvae and collection of adults and whether adult monitoring can be used as a predictive management tool.

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