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Responses of *Diabrotica speciosa* to a Semiochemical Trap Characteristics

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ABSTRACT

Responses of Diabrotica speciosa *(Germar) (Coleoptera: Chrysomelidae) to a semiochemical trap characteristics were investigated in the field. The trap consisted of plastic bottles with several perforations (0.5 cm diameter and 2.0 cm distance each other) and containing* Lagenaria vulgaris *L. (Cucurbitaceae) powder as cucurbitacin (arrestant and phagostimulant) source (0.28%). In common bean fields, transparent green traps caught significantly more males and females beetles than yellow, transparent and white traps. Yellow traps caught significantly more females than white traps. Transparent green and yellow traps baited with the volatile attractant 1,4-dimethoxybenzene caught 4.08 and 2.72 times more beetles than unbaited, respectively. Higher number of beetles was caught by 2L bottle traps than 1, 0.5 and 0.25 mL. In corn fields, transparent green bottle traps caught significantly more beetles in Campo Mourão and similar captures were found in Londrina field.*

Key words: Insecta, kairomones, diabroticite, cucurbitacin, volatile attractant.

INTRODUCTION

Diabrotica speciosa (Germar) (Coleoptera: Chrysomelidae) damages several crops throughout Latin America. Adult leaf beetles are key pests in common beans (*Phaseolus vulgaris* L.), vegetables and fruit orchards. Larvae attack roots of corn (*Zea mays* L.), wheat (*Triticum aestivum* L.) and potatoes (*Solanum tuberosum* L.). Control measures for both stages include only chemical insecticides. Semiochemicals from plants of the Cucurbitaceae family have been tested as adequate for developing alternative measures to manage diabroticites. Cucurbitacins are extremely bitter plant chemicals that are toxic or repellent to non-adapted phytophagous arthropods (Costa and Jones, 1971). However they are arrestants and phagostimulants to adult diabroticites (Metcalf et al., 1980; Metcalf and Metcalf, 1992). In North-American crops, traps and baits with cucurbitacin are being used to manage *D. virgifera virgifera* LeConte, *D. barberi* Smith and Lawrence and *D. virgifera zeae* Krysan and Smith (Chandler and Faust, 1998). In Brazil, yellow traps containing cucurbitacins were used successfully to monitor *D. speciosa* and *Cerotoma arcuata tingomariana* Bechiné in a common bean field (Ventura et al. 1996). Besides cucurbitacins, diabroticites respond to volatile attractants from *Cucurbita maxima* Duchesne blossoms (Metcalf and Metcalf, 1992). Males and females of *D. speciosa* are attracted by 1,4-dimethoxybenzene and captures increase significantly with higher doses of this compound (Ventura et al. 2000), suggesting a probable application of the mass-trapping concept (Hoffmann et al. 1996).

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The first cucurbitacin trap designed for capturing *Diabrotica* spp. was built with an amber plastic vial, measuring 3 cm in diameter and 9 cm in length (Shaw et al. 1984). Although suitable for monitoring, the magnitude of the captures was insufficient to control the pests. In a more recent study, Ventura et al. (2005) evaluated methods of luring insects to traps (color, volatile attractant), design of volatile attractant dispenser and trap entry ports, and means of retaining trapped insects (cucurbitacin, insecticide and adhesive). Traps must be cheap and user-friendly to be widely adopted by farmers (Whitworth et al. 2002). Constant refinements in traps may improve captures and consequently diminish number of traps per area, reducing control costs. Hence, aiming to improve efficiency and reduce costs some assays were carried out in common bean and corn fields. Trap colors in the best design established before were compared (Ventura et al. 2005); the interactions of transparent green and yellow traps with the volatile attractant 1,4-dimethoxybenzene and the influence of four sizes of bottle traps in the captures of *D. speciosa.*

MATERIAL AND METHODS

Lagenaria vulgaris was used as source of cucurbitacin and cultivated in green house. Field experiments were carried out in the School Farm of the Universidade Estadual de Londrina School Farm (Latitude 23^o 19'S, Longitude 51^o 12'W) and Experimental Farm of COAMO - Cooperativa Agropecuária Mourãoense in Campo Mourão (Latitude 24^o 02'S, Longitude 52^o 22'W) in the state of Paraná, in Brazil. Common bean, cv. IAPAR 59, fields (sown on September 09, 2000; March 25, 2001 and May 25, 2001) were used as testing sites due to the natural occurrence of high populations of *D. speciosa* in Londrina. Corn (cv. AG 32), crop in which *D. speciosa* breeds, was sown on October 22, 2003 in Londrina and October 5, 2003 in Campo Mourão. Traps were placed 20 cm above the plant canopy in the interior of common bean field and on the ground in the edges of corn fields.

Traps were made using plastic bottles (originally used as soft drink containers). Several perforations (0.5 cm diameter, 2 cm of distance each other) were made in the plastic bottle to allow insects to enter into the trap. Green fruits of *L. vulgaris* were dried in a drying oven at 70^o C and ground in a blender. Plastic strips covered with *L. vulgaris* powder (0.28% cucurbitacin) were sprayed with Carbaril insecticide [Sevin 480 SC (2.25 mL/L)] and placed inside the trap (model proposed by Ventura et al. 2005). One small cut was made 7.5 cm height to put water and to remove insects when their number was recorded.

Trap colors

Trap colors were tested in common bean and corn fields. In common bean fields, transparent, transparent green, golden yellow and white bottle (2 L) traps were compared (N = 7). The golden yellow and white traps were transparent bottles coated with Suvinil Paint (BASF S.A., São Bernardo do Campo, São Paulo, Brazil). Strips containing *L. vulgaris* were 3.5 X 25.0 cm. Traps were placed in the field on July 29, 2003, and insects collected 48 hours later. Insects were sexed in the laboratory (White, 1977) because the responses of males and females to colors used in this experiment were not known.

In corn fields, golden yellow and transparent green traps were compared (N = 4). In Londrina corn field, traps were placed in the field on October 24, 2003 and assessments were done October 26, 28 and 30; November 1, 3, 5, 7, 10, 12, 14, 18, 21, 23, 26 and 28 and December 2, 2003. In Campo Mourão corn field, traps were placed in the field on October 9, 2003 and assessments were done October 13, 15, 20, 22, 24, 27, 29 and 31; November 3, 7, 10, 12, 14, 18, 21, 23, 26 and 28 and December 2, 2003. Insects from Londrina corn field were sexed because proportion of sexes captures in this crop was not established before.

Interaction between color and volatile attractant

To evaluate the interaction of color trap and volatile attractant, yellow and transparent green bottle traps (2 L), baited and unbaited with the volatile attractant 1,4-dimethoxybenzene (N = 5) were used. Dispensers containing volatile were provided by ChemTica Internation (San Jose, Costa Rica) and attached to the top of the trap. The volatile average release rate (over 10 days) per dispenser was approximately 32 mg/day under laboratory conditions. Traps were placed in the field on September 3, 2003. Two assessments were conducted, 48 and 96 h after trap placement in the field.

Trap sizes

Four trap sizes were compared (0.25, 0.5, 1 and 2 L bottles) (N = 7). Traps were placed in the field on August 23, 2003. Assessment was carried out 48 h after trap placement in the field.

Experimental Design and Statistical Analysis

Experiments were conducted in a randomized complete block design. In common bean field, distance between traps was 5m within a block and 10m between blocks. In corn fields, distance between traps was 10m and each assessment was considered one replicate. The analysis of variance (ANOVA) was performed. The paired t-test (two treatments) and Duncan's multiple range test (more than two treatments) were used to compare means.

RESULTS

Trap colors

In common bean field, the number of the insects caught in transparent green traps was significantly higher than those caught by yellow, transparent and white traps, for both females and males (Table 1). For females, yellow traps caught significantly more insects than white traps. No difference was found between captures by yellow and transparent traps. For males, there were no significant differences among yellow, transparent and white traps.

Table 1 - Mean number (± SE) of *Diabrotica speciosa* beetles caught by colored traps in common bean field after 48 h. Londrina, PR (July, 2003).

Treatment	Beetles[1]	
	Males	Females
Transparent green	7.7 ± 2.0a	13.3 ± 0.9a
Yellow	2.9 ± 0.8b	7.0 ± 1.1b
Transparent	2.4 ± 0.7b	4.7 ± 1.5bc
White	0.9 ± 0.3b	1.9 ± 0.8c

[1] Means in the same column with different letter are significantly different based on Duncan's multiple rang rest ($P < 0.05$), N = 7.

Table 2 - Mean number (± SE) of *Diabrotica speciosa* caught by transparent green and yellow, baited and baited with 1,4-dimethoxybenzene (N = 5) after 48 and 96 hs. Londrina, PR (September, 2003).

Treatment	Beetles[1]	
	48h	96h
Transparent green	105.6 (11.1)bc	247.0 (33.3)c
Baited transparent green	436.8 (61.2)a	994.6 (87.3)a
Yellow	65.4 (13.9)c	231.0 (19.9)c
Baited Yellow	211.6 (14.8)b	512.6 (17.0)b

[1] Means in the same column with different letter are significantly different based on Duncan's multiple rang rest ($P < 0.05$), N = 5.

Table 3 - Mean number (± SE) of *Diabrotica speciosa* beetles caught by different size transparent green traps in common bean field after 48 h. Londrina, PR (August 2003).

Treatment	Beetles (± SE)
2 L	108.3 (28.9)a
1 L	41.4 (7.4)b
0.5 L	54.9 (9.0)b
0.25 L	15.0 (3.0)c

Means with different letter are significantly different based on Duncan's multiple range test (P,0.05), N=7.

In corn field, similar captures between golden yellow and transparent green traps were found in Londrina (t = 1.52; df=15; and P < 0.15) and transparent green traps captured more beetles (means 1.4 more) than golden yellow traps in Campo Mourão (t = 4.07; df=12; p < 0.002) (Fig. 1). Sex ratio (females per male) was 1.72 for yellow and 1.76 for transparent green traps in Londrina corn field.

Interaction between color and volatile attractant

A significant interaction between trap color and presence of volatile attractant was found (F = 26.01** and 55.28** for the first and second assessments, respectively), indicating that the attractant influenced differently captures. The increment of captures by adding 1,4-dimethoxybenze was 4.13 and 4.01 times in the transparent green traps and 3.23 and 2.21 times in the yellow traps (Table 2). Transparent green traps baited with 1,4-dimethoxybenzene caught significantly more beetles than the other treatments (Table 2). Baited yellow traps caught significantly more beetles than unbaited transparent green and yellow traps.

No differences were found between transparent green and yellow traps (Table 2) as observed before (Table 1). Baited transparent green traps caught 2.06 and 1.9 times more beetles than baited yellow traps in the first and second assessments, respectively.

Trap size

The number of insects caught by 2 L bottle traps was significantly higher than that caught by 1, 0.5 and 0.25 mL bottle traps (Table 3). Significant differences were not found among 1, 0.5 and 0.25 mL traps.

DISCUSSION

The lack of difference between golden yellow versus transparent traps for *D. speciosa* (Table 1) do not corroborate previous study in which golden yellow was clearly more attractive (Ventura et al., 2005). However, the authors used a different trap (750 mL plastic cups coated with insect adhesive without semiochemicals) what could explain the differences in the results. For *D. barberi,* yellow traps caught 3.4 times more beetles than transparent traps (Ladd et al., 1984). Saturn yellow was the most attractive color for *D. virgifera virgifera* and *D. barberi* from a series of colors tested (Hesler and Sutter, 1993).

Transparent green traps caught almost two times more beetles than yellow traps in common bean in a low beetles density field (Table 1) and similar captures were found in a high density field (Table 2). The transparent green had similar performance than yellow trap in Londrina and higher in Campo Mourão corn field (Fig. 1). However, when baited with 1,4-dimethoxybenzene, transparent green traps showed significant better performance than yellow traps in common bean field (Table 2). Replacement of yellow by transparent green traps was a favorable finding since these bottles were easily obtained by recycling and were not painted, which contribute to cost and labor reduction.

Significant interactions between trap colors and attractants in the capture of *D speciosa* (Table 2) corroborate results obtained with *D. virgifera virgifera* (Hesler and Suter, 1993) in which interactions were also found between trap grant and attractant. However, in a series of experiments with four species of diabroticites, Hoffman et al. (1996) found significant interactions for *D. undecimpunctata undecimpunctata* Mannerheim. Higher number of insects caught by 2 L bottle traps (Table 2) corroborated reports of rising captures of *Diabrotica* spp. with increases in the size of the trap (Youngman et al., 1996).

The trap proposed in this study [transparent green baited trap (Fig.2) could be a suitable tool to manage *D. speciosa* populations which fitted on the artificial trap crop concept (Deen-Dickson and Metcalf, 1995). The bottle trap is easy to build and to handle. The materials and plant are easily obtained and could be reused in successive plantings. Further investigation could establish the number of traps, the time and place in the crop to reduce *D. speciosa* population above damage threshold in different crops.

In summary, bottle transparent green traps caught significantly more *D. speciosa* females and males than yellow, white and transparent traps in common bean fields; bottle transparent green traps caught significantly more beetles in a corn field in Campo Mourão; the volatile 1,4-dimethoxybenzene incremented significantly the captures of *D. speciosa* by yellow and transparent green traps [means 4.08 and 2.72 more beetles, respectively); bottle traps of 2 L caught significantly more beetles than 1, 0.5 and 0.25 mL bottle traps. Due to amount of beetles caught per traps, transparent green bottle traps (2 L) were suitable for monitoring and mass trapping studies for *D. speciosa* management.

RESUMO

Respostas de *Diabrotica speciosa* (Germar) (Coleoptera: Chrysomelidae) a características de uma armadilha contendo semioquímicos foram investigadas no campo. As armadilhas consistiam de garrafas plásticas com vários orifícios (0,5cm de diâmetro e 2 cm de distância entre eles) e continham pó de *Lagenaria vulgaris* L. (Cucurbitaceae) como fonte de cucurbitacina (arrestante e fagoestimulante) (0,28%). No feijão comum, armadilhas verdes transparentes capturaram significativamente mais insetos machos e fêmeas que armadilhas amarelas, transparentes e brancas. Armadilhas amarelas capturaram significativamente mais fêmeas que armadilhas brancas. Armadilhas verdes transparentes e amarelas com o atraente volátil 1,4-dimetoxibenzeno capturaram 4,08 e 2,72 mais insetos do que aquelas sem o volátil, respectivamente. Maior número de insetos foi encontrado em armadilhas confeccionadas em garrafas de 2000 mL do que em garrafas de 1000, 500 e 250 ml. Em campos de milho, armadilhas verdes transparentes capturaram mais insetos em Campo Mourão e similar número foi encontrado em Londrina.

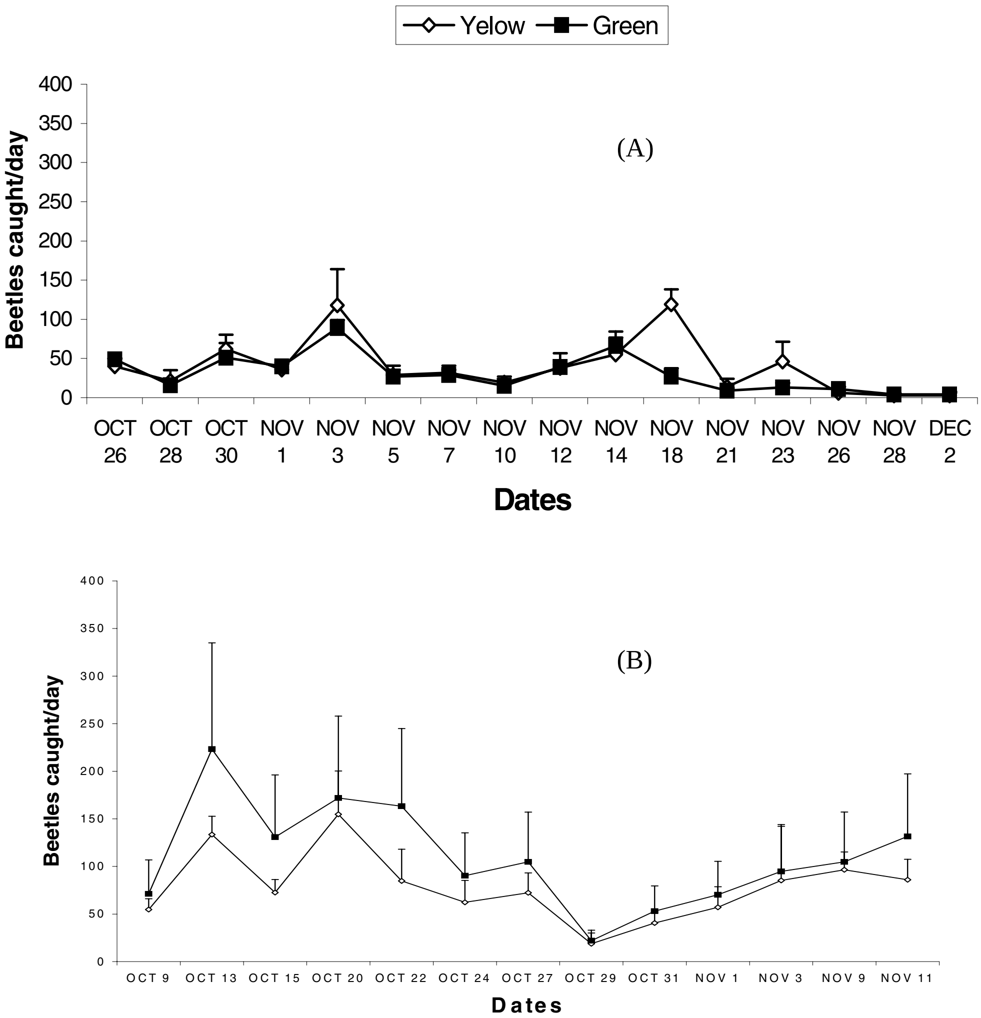

Figure 1 - Mean number (+ SE) of *Diabrotica speciosa* beetles caught by transparent green and golden yellow bottle traps in corn fields in several assessments in the field. Londrina (A) e Campo Mourão (B), PR (October and November e December, 2003).

Figure 2 - A sample of transparent green trap containing strip covered with *Lagenaria vulgaris* powder and volatile attractant in the dispenser.

REFERENCES

Chandler, L. D. and Faust, R. M. (1998), Overview of areawide management of insects. *J. Agric. Entomol*., **15**, 320-325.

Costa, C. P. and Jones, C. M. (1971), Cucumber beetle resistence and mite susceptibility controlled by the bitter gene in cucumin sativus L. *Science* **172**, 1145-1146.

Deen-Deckison, L. and Metcalf, R. L. (1995), Attractants for adults corn rootworm monitoring and control. In: Agricultural Pesticide Conference, 3-6., Illinois *Proceedings* … U. Illinois, Urbana, Il. pp. 185.

Hesler, L. S. and Sutter, G. R., (1993), Effect of trap color, volatile attractants and type of toxic bait dispenser on captures of adults rootworm beetles (Coleoptera: Chrysomelidae). *Environ. Entomol.*, **22**, 743-750.

Hoffman, M. P.; Kirkwyland, J. J.; Smith, R. F. and Long, R. F. (1996), Field tests with kairomone-baited traps for cucumber beetles and corn rootworms in cucurbits. *Environ. Entomol.*, **25**, 1172-1181.

Ladd Jr., T. L.; Stiner, B. R. and Krueger, H. R. (1984), Influence of color and height of eugenol-baited sticky traps on attractiveness to northern corn rootworm beetles (Coleoptera: Chrysomelidae). *J. Econ. Entomol.*, **77**, 652-654.

Metcalf, R. L. and Metcalf, E. R. (1992), *Plant kairomones in insect ecology and control*. Contemporary topics in Entomology. Routledge: Chapman and Hall.

Metcalf, R. L.; Metcalf, R. A. and Rhodes, A. M. (1980), Cucurbitacins as kairomones for diabroticite beetles. *Proc. Natl. Acad. Sci.*, **77**, 3769-3772.

SAS Institute (1989), SAS/STAT: *User's Guide, Version 6*. 4th ed. Cary, NC.: SAS Institute.

Shaw, J. T.; Ruesink, W. G.; Briggs, S. P. and Luckmann, W. H. (1984), Monitoring populations of corn rootworm beetle (Coleoptera: Crysomelidae) with trap bait with cucurbitacins. *J. Econ. Entomol.*, **77**, 1495-1499.

Ventura, M. U.; Resta, C. C. M.; Nunes, D. H. and Fujimoto, F. (2005), Effects of trap attributs on capture of *Diabrotica speciosa* (Coleoptera: Chrysomelidae) on common bean fields. *Scientia Agric.* [In press].

Ventura, M. U.; Martins, M. C. and Pasini, A. (2000), Responses of *Diabrotica speciosa* and *Cerotoma arcuata tingomariana* (Coleoptera: Chrysomelidae) to volatile attractants. *Florida Entomol.*, **83**, 403-410.

Ventura, M. U.; Ito, M. and Motalván, R. (1996), An attractive trap to capture *Diabrotica speciosa* (Ger.) and *Cerotoma arcuata tingomariana* Bechiné. *Neot. Entomol.*, **25**, 529-535.

White, R. Sexual characters of species of *Diabrotica* (Chrysomelidae: Coleoptera). *Ann. Entomol. Soc. Am.*, **70**, 168.

Whitworth, R. J., Wilde, G. E., Shufran, R. A. and Milliken, G. A. (2002) Comparasion of adult corn rootworm (Coleoptera: Chrysomelidae) sampling methods. *J. Econ. Entomol.*, **95**, 96-105.

Yougman, R. R., Kuhar, T. P. and Midgarden, D. G. (1996), Effect of trap size on efficiency of yellow sticky traps for sampling western corn rootworm (Coleoptera: Chrysomelidae) adults in corn. *J. Entomol. Sci.*, **31**, 277-285.

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