Capture of Melon Flies and Oriental Fruit Flies (Diptera: Tephritidae) in Traps Baited with Torula Yeast-Borax or CeraTrap in Hawaii

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Capture of melon flies and oriental fruit flies (Diptera: Tephritidae) in traps baited with torula yeast-borax or CeraTrap in Hawaii

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Southern states within the USA, most notably California, Florida, and Texas, operate trapping networks to detect invasive tephritid fruit flies (Diptera: Tephritidae), which pose a major threat to local fruit and vegetable industries (IPRFFSP 2006). Detection is based primarily on traps baited with male-specific chemicals, but food-baited traps, which attract both sexes, remain an important component of the monitoring effort. While the food bait used in Texas and Florida programs is a dry synthetic blend of food attractants (ammonium acetate and putrescine alone or in combination with trimethylamine), the food bait used in the California fruit fly detection system is an aqueous solution of hydrolyzed torula yeast-borax pellets (Burditt 1982; Scentry Biologicals Inc., Billings, Montana, USA). Recently, an alternative liquid bait derived from enyzymatic hydrolyzed animal protein, and known commercially as CeraTrap (Bioibérica, Barcelona, Spain), has been developed and found to be more attractive than the standard hydrolyzed yeast to the Mediterranean fruit fly (medfly), *Ceratitis capitata* (Wiedemann) (Shelly & Kurashima 2016) and various *Anastrepha* species (e.g., Lasa et al. 2015; Bortoli et al. 2016).

The subtribe Dacina (Dacinae: Dacini) contains many important agricultural pests in the genera *Bactrocera*, *Dacus*, and *Zeugodacus* (Virgilio et al. 2015). To our knowledge, only 2 studies have compared the effectiveness of CeraTrap-baited traps with other food-baited traps for any species within the Dacina. Royer et al. (2014) found CeraTrap-baited traps captured significantly fewer females of the Australian species *Bactrocera cucumis* (French) than traps baited with cucumber volatile or orange ammonia. In Hawaii, Shelly and Kurashima (2016) reported that both sexes of the melon fly, *Z. cucurbitae* (Coquillett), were captured in greater numbers in traps baited with torula yeast-borax than CeraTrap. The objectives of the present study were to gather (i) additional data on the relative captures of melon flies in traps baited with torula yeast-borax or CeraTrap for comparison with earlier results, and (ii) initial data on relative effectiveness of these 2 food lures in capturing oriental fruit flies, *B. dorsalis* (Hendel).

Field work was conducted during Mar to May 2017 in an area of mixed plantings (about 2 ha) at the Hawaii Agriculture Research Center, Kunia, Oahu, Hawaii. Several fruit fly host plants were present, including papaya (*Carica papaya* L.) (Caricaceae), coffee (*Coffea arabica* L.) (Rubiaceae), mango (*Mangifera indica* L.) (Anacardiaceae), cherry tomato (*Solanum lycopersicum* L. var. *cerasiforme* [Dunal] Spooner, G.J. Anderson & R.K. Jansen) (Solanaceae), and bitter melon (*Momordica charantia* L.) (Cucurbitaceae). Multilure traps (FAO/IAEA 2013; N = 30 total; Better World Manufacturing, Fresno, California, USA) were placed 1 to 1.5 m above ground in shaded locations within non-host trees (*Leucaena leucocephala* [Lam. De Wit]) (Fabaceae) and were separated by at least 15 m. Half of the traps were baited with torula yeast-borax and the other half with CeraTrap; synthetic food-based lures were not included, as Leblanc et al. (2010) found they were less attractive than torula yeast-borax traps to either *Z. cucurbitae* or *B. dorsalis*. The torula yeast-borax slurry was prepared by placing 1 standard pellet per 100 ml of water and aging the solution 2 d prior to deployment. CeraTrap is sold ready for use and was used straight from the bottle. No preservatives (e.g., propylene glycol) were used in the traps, all of which held 300 ml of the respective baits. In the field, the trap's liquid was poured through a sieve to retain captured insects, which were returned to the laboratory for counting. Traps were operated for 6 wk and serviced weekly. Torula yeast-borax bait was replaced weekly, whereas the CeraTrap was recycled and replenished as needed. Locations of the 2 food baits were alternated between successive weeks to minimize position effects.

Raw data were $\log_{10}$ transformed and analyzed with a 3-way ANOVA, with wk, bait type, and fly sex as the main effects. Transformed data met the parametric assumptions of normality and equal variance for *Z. cucurbitae* but only the equal variance assumption for *B. dorsalis*. For the latter species, however, a non-parametric equivalent of ANOVA using ranked data (Conover & Iman 1981) yielded results identical to those obtained using the raw data, indicating that the parametric analyses of raw data were sufficiently robust to accommodate the level of non-normality present. Pairwise multiple comparisons were made using the Holm-Šidák method (test statistic *t*). Statistical analyses were performed using SigmaPlot 11.0 (Systat Software, San Jose, California, USA).

For *Z. cucurbitae*, bait ($F_{1, 336}$ = 42.9; P < 0.001) and wk ($F_{5, 336}$ = 5.1; P < 0.001) had significant effects on captures, but fly sex did not ($F_{1, 336}$ = 0.05; P = 0.82; Fig. 1). Independent of the other main effects, captures in torula yeast-borax-baited traps were significantly higher than those in CeraTrap-baited traps (t = 6.6; P < 0.001). Temporal variation in captures reflected a U-shaped trend, with captures in both trap types greater at the start and end of the sampling period and lower in the middle wk. None of the interaction terms was significant (all P > 0.05).

For *B. dorsalis*, wk ($F_{5, 336}$ = 6.1; P < 0.001) had a significant effect on captures, but bait ($F_{1, 336}$ = 0.1; P = 0.71) and sex ($F_{1, 336}$ = 2.8; P = 0.09) did not (Fig. 2). The significant temporal variation derived primarily from the increase in captures in wk 6, as the significant pairwise differences detected were between wk 6 and wk 1-4, respectively. One interaction (bait × week) was significant ($F_{5, 336}$ = 2.8; P = 0.02), which reflected the change in the relative captures of the 2 trap types over time (i.e., torula yeast-borax-baited traps had higher captures at the start but lower captures at the end of the study period).

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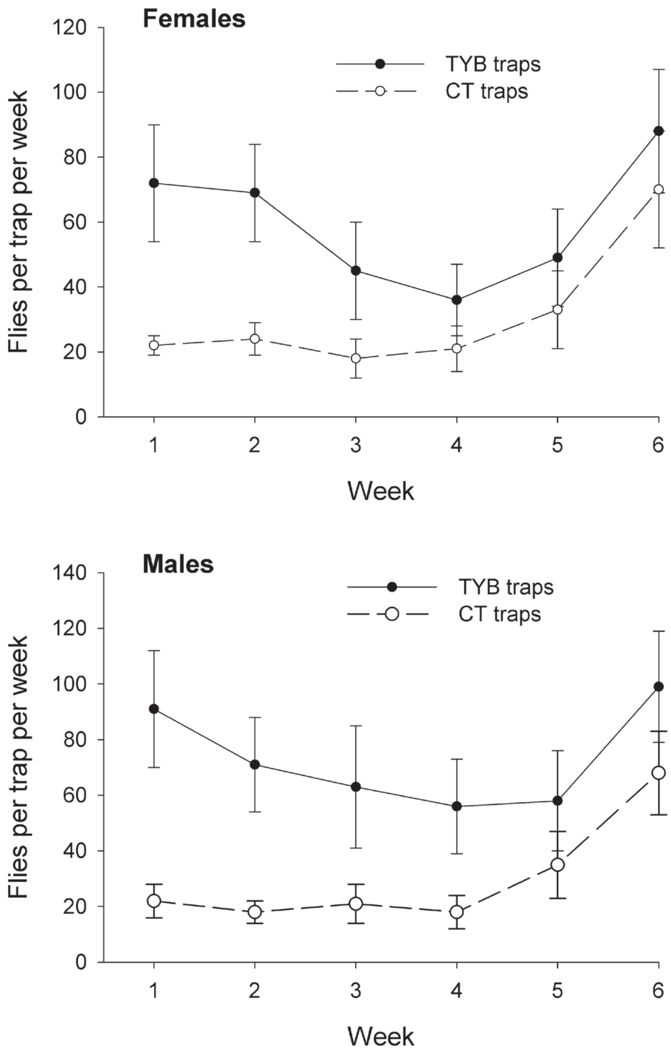

Fig. 1. Numbers of female and male *Z. cucurbitae* captured in Multilure traps baited with torula yeast-borax pellets (TYB) or CeraTrap (CT) over the 6-wk sampling period. Symbols represent averages of 15 traps per bait type; whiskers represent + 1 SE.

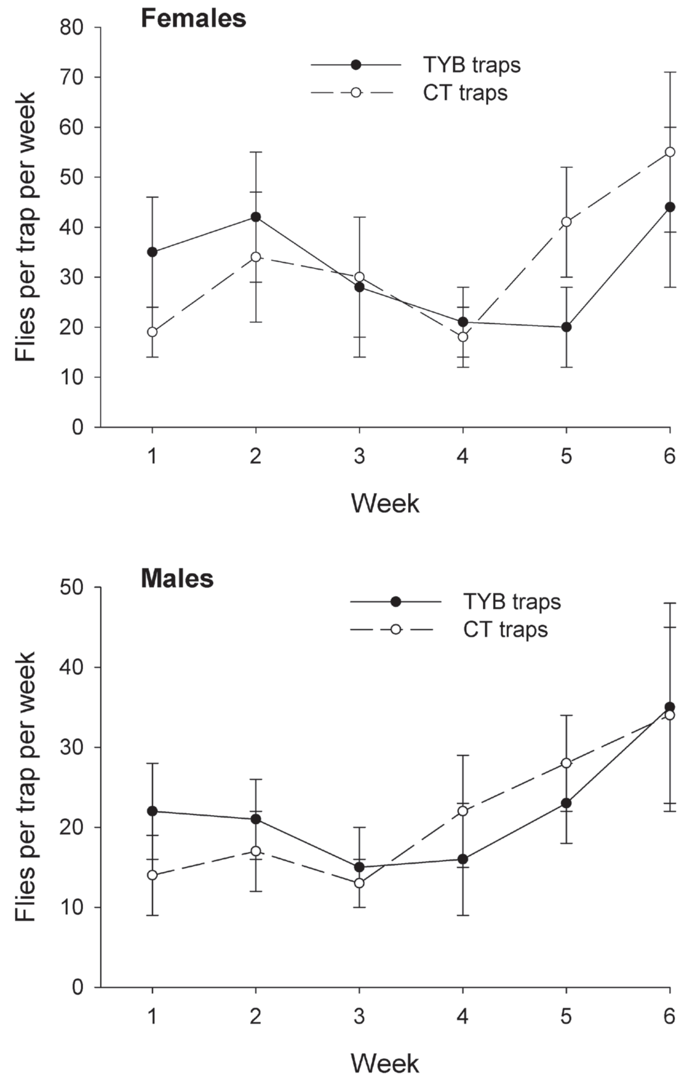

Fig. 2. Numbers of female and male *B. dorsalis* captured in Multilure traps baited with torula yeast-borax pellets (TYB) or CeraTrap (CT) over the 6-wk sampling period. Symbols represent averages of 15 traps per bait type; whiskers represent + 1 SE.

The present study reveals interspecific differences in the relative attractiveness of torula yeast-borax and CeraTrap food lures. Consistent with earlier findings (Shelly & Kurashima 2016), torula yeast-borax-baited traps here were found to be more attractive to *Z. cucurbitae* than CeraTrap-baited traps. The data for *B. dorsalis*, which constitute the 1st documented comparison between these food lures for this species, revealed similar attraction to torula yeast-borax- and CeraTrap-baited traps. In contrast to these species, captures of medfly have been found to be higher in CeraTrap- than torula yeast-borax-baited traps (Shelly & Kursahima 2016). In addition to the financial costs of different lures and the associated trap servicing practices, this study echoes Diaz-Fleischer et al. (2009) in highlighting the need to acknowledge differences among tephritid species in their response to different food lures and to consider this variation when developing area-wide detection programs.

Summary

Food baits are a key component in trapping programs to detect infestations of pest species of tephritid fruit flies (Diptera: Tephritidae). Traditionally, a torula yeast-borax slurry has been used most frequently, but the recently developed food bait CeraTrap, consisting of hydrolyzed animal protein, has proven more attractive to certain tephritids. This study compared field captures of melon flies, *Zeugodacus cucurbitae* (Coquillett), and oriental fruit flies, *Bactrocera dorsalis* (Hendel), in traps baited with torula yeast-borax or CeraTrap in an agricultural setting in Hawaii. Data show that melon flies were captured in significantly greater numbers in traps baited with torula yeast-borax than CeraTrap, while no difference in captures was noted for the oriental fruit fly between traps baited with the 2 food types.

Key Words: food attractants; detection trapping; *Zeugodacus cucurbitae*, *Bactrocera dorsalis*

Sumario

Los cebos alimenticios son un componente clave en los programas de captura para detectar infestaciones de especies de moscas de la fruta tefrítidas (Diptera: Tephritidae). Tradicionalmente, se ha utilizado con mayor frecuencia una suspensión de torula levadura-bórax, pero el cebo alimenticio recientemente desarrollado CeraTrap, que consiste en proteína animal hidrolizada, ha demostrado ser más atractivo para ciertos tefrítidos. Este estudio comparó capturas de campo de la mosca de melón, *Zeugodacus cucurbitae* (Coquillett) y la mosca de la fruta oriental, *Bactrocera dorsalis* (Hendel), en trampas cebadas con torula levadura-bórax o CeraTrap en un entorno agrícola en Hawaii. Los datos muestran que las moscas de melón fueron capturadas en números significativamente mayores en trampas cebadas con torula levadura-bórax que CeraTrap, mientras que no se observaron diferencias en las capturas para la mosca de la fruta oriental entre las trampas cebadas con los 2 tipos de alimentos.

Palabras Clave: Atrayentes de alimentos; detección de trampas; *Zeugodacus cucurbitae*, *Bactrocera dorsalis*

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