NOTE

A Novel Cage Design for Investigating Tritrophic Insect-Plant Interactions[1]

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A study currently being conducted investigating intercrops of canola (*Brassica napus* L.) and wheat (*Triticum aestivum* L.) required cages that provided an arena into which predatory beetles could be introduced to predate eggs of the cabbage maggot, *Delia radicum* (L.) (Diptera: Anthomyiidae), in an artificial enclosure with plant populations and soil that simulated a natural field environment. We could find no suitable preexisting cage design and concluded that a cage combining a planter box with a removable screened component above the box was most appropriate. Available insect cage designs required the use of potted plants placed on the cage floor, which is sufficient for studying flying insects but unacceptable for ground-searching predators as their movements would be impeded by the pots.

Cages were constructed in 2 components, as shown in Fig. 1. The lower, planter component consisted of a frame (50 × 50 × 21 cm) of 3.8 × 3.8 cm pine wood boards with sheets of 0.8 cm plywood fastened to the sides, 50 × 18 cm, and bottom, 50 × 50 cm. The upper, cage component consisted of a frame (50 × 50 × 50 cm) of 3.8 × 3.8 cm boards with 300-μm-mesh nylon screen affixed to the top and 3 sides using silicone and staples. The front of the upper component had grooved pieces of pine wood fastened by screws to the frame to serve as a track for a 44.5 × 44.5 cm pane of 5-mm plexiglass inserted against the frame. The screws allowed the track pieces to be removed as needed to slide out the plexiglass and "open" the door so that plants in the cage could be accessed or insects could be introduced or removed, as needed. The lower component had short upright posts inside 2 diagonally opposing corners, onto which the upper component fit snugly into place. Upper and lower components were secured together by one sash lock on each side of the cage. Closed cell foam weather stripping placed on the bottom of the cage frame helped seal the 2 components. Upper and lower components were constructed as matched pairs to ensure a tight seal between them, so that introduced beetles did not escape. Additional foam weather

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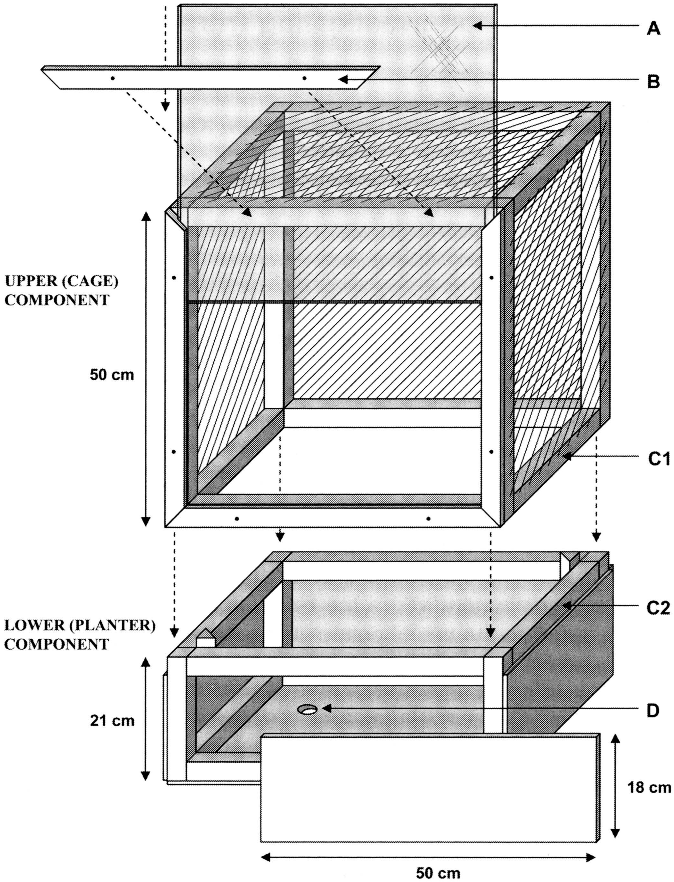

Fig. 1. Diagram of the two-part insect cage. Dashed lines show movement or position of cage components. Foam weather stripping between upper and lower components, and hardware for connecting frame pieces, side-boards, and screen are not shown. The front panel of the lower component has been removed to show a drain hole inside the planter. (A) Plexiglass door (44.5 × 44.5 cm, 5 mm thick); (B) door track piece (3.8 cm wide, 1.6 cm thick, 50 cm maximum length); (C) locations of sash lock components, repeated on opposite side of cage: C1 = locking portion of sash lock, C2 = stationary hook of sash lock; (D) drain hole, screen over drain hole not shown.

stripping between the 2 components was added to some cages after the wooden frames warped slightly prior to introduction of the study insects.

Four 2-cm diam holes were drilled in the planter bottoms to allow water to escape if over-watering should occur. Pieces of screen were affixed over these holes using silicone and staples to prevent insects from escaping should they burrow to the planter bottoms. Following assembly of the wooden frames, sideboards, and tracks, and prior to affixing the screen or inserting the plexiglass door, all wooden portions of the cage were sprayed with 3 coats of spar varnish. This provided a water-resistant covering to the wood to reduce or eliminate rot, as the cage, particularly the lower component, would be moist for extended periods.

Height of the upper component was selected because plants in the intercropping experiment did not need to reach maturity and full height. Cages could be constructed with different dimensions depending on the intended use; however, increased cage dimensions would result in added costs due to greater amounts of construction materials required.

A study was conducted using these cages under greenhouse conditions, for which 36 cages were constructed. The study included 6 treatments and 8 replicates of each treatment type; some cages were used more than once. Lower planter components were filled with potting soil, and crops were seeded as required for the study. Plants were watered through the door or, when insects were not present in the cage, by opening the sash locks and lifting the upper component. The cages were stocked with eggs of *D. radicum* and adult specimens of either *Bembidion quadrimaculatum* (L.) (Coleoptera: Carabidae), a small generalist predator, or *Aleochara bilineata* Gyllenhal (Coleoptera: Staphylinidae), a parasitoid of *Delia* spp. puparia. The cages provided an environment in which eggs were consumed by the beetles in varying quantities according to treatment type, and all of the beetles were recovered at the end of the study, indicating that the mesh screening and other sealing components were effective. Plants were vigorous throughout the study, and the soil depth and draining mechanism of the cages prompted satisfactory root development of both plant species tested. On conclusion of the experiment, cage tops were removed from planter bottoms to facilitate cleaning and storage of the cages.

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