EFFECTS OF SWEET ALYSSUM FLOWERS ON THE LONGEVITY OF THE PARASITOID WASPS *COTESIA MARGINIVENTRIS* (HYMENOPTERA: BRACONIDAE) AND *DIADEGMA INSULARE* (HYMENOPTERA: ICHNEUMONIDAE)

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ABSTRACT

The effects of sweet alyssum (*Lobularia maritima*) (Brassicaceae) flowers on the longevity of two augmentatively-released parasitoids, *Cotesia marginiventris* (Cresson) (Hymenoptera: Braconidae) and *Diadegma insulare* (Cresson) (Hymenoptera: Ichneumonidae), were studied in a greenhouse experiment. *C. marginiventris* and *D. insulare* survived approximately 4.8 and 12.7 times longer, respectively, when provisioned with honey or with sweet alyssum than with water alone. Sweet alyssum planted in northern Florida cabbage fields may be one way to improve biological control by augmentatively-released natural enemies of lepidopteran pests by increasing adult parasitoid longevity during times when few wild plants are in bloom.

Key Words: biological control, conservation, augmentation, *Brassicaceae*

RESUMEN

Se estudiaron los efectos de flores de *Lobularia maritima* (Brassicaceae) en la longevidad de dos parasitoides, *Cotesia marginiventris* (Cresson) (Hymenoptera: Braconidae) y *Diadegma insulare* (Cresson) (Hymenoptera: Ichneumonidae), liberados de

manera incremental bajo condiciones de invernadero. *C. marginiventris* y *D. insulare* sobrevivieron aproximadamente 4.8 y 12.7 veces más tiempo, respectivamente, cuando se les alimentó con miel o con flores de *L. maritima,* que cuando se les alimentó sólo con agua. En el Norte de Florida, la siembra de plantas de *L. maritima* dentro de cultivos de col podría ser una manera de mejorar el control biológico de plagas lepidópteras. De esta manera, la longevidad de los parasitoides adultos se incrementaría cuando existan pocas plantas de *L. maritima* creciendo de manera silvestre.

Conservation of adult parasitoid populations in an agroecosystem so that they may be available at times of increased pest densities is an important consideration in the implementation of biological control programs. Adult parasitoid wasps visit wild flowers in the field (Leius 1960), and access to these and other (i.e. host fluids, homopteran honeydew) carbohydrate sources may increase parasitoid longevity (e.g. van Emden 1963a, 1963b, 1964, 1965, Leius 1967; van den Bosch & Messenger 1973; Syme 1975). Clausen (1956) suggests that some failures of biological control programs may have been due to the lack of suitable food for the adult parasitoids. Therefore, direct provisioning of a carbohydrate source in agroecosystems may help maintain local populations of natural enemies for biological control of pests.

In cabbage fields in northern Florida, augmentative biological control programs are being implemented as one tactic in a pilot Integrated Pest Management (IPM) program to control lepidopterous pests such as the diamondback moth, *Plutella xylostella* (L.) (Lepidoptera: Plutellidae), and the cabbage looper, *Trichoplusia ni* (Hübner) (Lepidoptera: Noctuidae) (Mitchell et al. 1997a). Other tactics include the use of pheromone for mating disruption (Mitchell et al. 1997c), and surrounding fields with collards as a trap crop for diamondback moth management (Mitchell et al. 1997b). Biological control agents often are released prior to outbreaks of larval populations so that they may be immediately available whenever pest outbreaks occur. *Cotesia marginiventris* (Hymenoptera: Braconidae) is a polyphagous parasitoid of early-instar lepidopteran larvae that is released to help manage cabbage looper populations. *Diadegma insulare* (Cresson) (Hymenoptera: Ichneumonidae) is a native host-specific parasitoid of the diamondback moth that is augmentatively-released earlier in the season than it normally appears. Previous studies demonstrated that the effectiveness of parasitoids may be influenced by the presence of wildflowers adjacent to *Brassica* crops (Idris & Grafius 1993, Zhao et al. 1992).

We have observed that few plants are in bloom during much of the cabbage growing season in northern Florida, so the direct provisioning of carbohydrate sources may be one way to enhance biological control by augmentatively-released *D. insulare* and *C. marginiventris.* Idris (1995) studied the effects of wild flowering plants on the longevity of *D. insulare.* Some flowering species were less effective than others, in part because the flower shape probably did not allow access to the nectar by these short-tongued wasps and/or because the nectar quality differed among the species. Two plants which significantly increased the longevity and fecundity of *D. insulare* were wild mustard (*Brassica kaber* (L.)) and wild carrot (*Daucus carota* (L.)). However, integrating these particular plants into cabbage agroecosystems in our area may be problematic because wild mustard is considered a weed by local growers, and wild carrot may not flower rapidly enough if planted at the same time as the cabbage.

A possible alternative flowering plant to include in the cabbage agroecosystem is sweet alyssum (*Lobularia maritima*) (L.) (Brassicaceae). Sweet alyssum is a non-weedy, hearty winter annual, which flowers rapidly and attracts large numbers of

natural enemies, including parasitic Hymenoptera, syrphids, and predatory bugs (Chaney 1998). Sweet alyssum is being used on a limited basis in California as an "insectary" for beneficial insects in lettuce (Chaney 1998), and is included in many "insectary seed blends" available commercially (e. g. Good Bug Blend™, Peaceful Vally Farm Supply, Grass Valley, CA; Border Patrol™, Garden City Seeds, Hamilton, MT). The first step in assessing the utility of using sweet alyssum to enhance natural enemies populations in cabbage is to determine the effects of this plant on the longevity of augmentatively-released parasitoid wasps. The goal of this study was to evaluate the longevity of *D. insulare* and *C. marginiventris* adult females provisioned with sweet alyssum as compared to the longevity of wasps supplied with honey or with no carbohydrate source.

Materials and Methods

All studies were conducted in cages located in a glasshouse under ambient light at the USDA-ARS Center for Medical, Agricultural and Veterinary Entomology in Gainesville, Florida. The cages were square, 30 × 30 × 30 cm with four sides of fine organdy cloth for ventilation. The cages were partially shaded with black shadecloth to protect against the afternoon sun. The in-cage temperatures ranged between 23 and 30°C. Studies were conducted between December, 1998 and April, 1999.

C. marginiventris were reared at the Gast Rearing Facility, USDA-ARS, Mississippi State University, MS, and shipped as pupae to our laboratory. *D. insulare* were reared at our laboratory from diamondback moth larvae feeding on collard leaves. Sweet alyssum (white-flowered) was grown from seed in our greenhouse or purchased from a local nursery which reportedly did not apply insecticides to the plants. The plants were used when they reached approximately 10 × 10 cm.

Ten newly-emerged female parasitoids were housed per cage. The parasitoids were housed with one of the following three treatments: a potted sweet alyssum plant plus a water-soaked cotton ball, honey plus a water-soaked cotton ball, or a water-soaked cotton ball. In the honey treatment, fresh honey (Sue Bee wildflower honey) was streaked on the cage screen every 2 days. Fresh water was provided to each cage daily. The alyssum was watered daily. Soil-filled pots were added to the cages without the sweet alyssum and watered daily to reduce effects of soil or humidity differences. Four replicates of each treatment were conducted for each species.

Cages were monitored daily to record the number of surviving wasps in the cage. Longevity was measured in days until mortality by recording the number of wasps alive on a given day; the remaining number were recorded as dead. The mean number of days until mortality per replicate for each treatment was calculated, an analysis of variance was conducted (JMP, SAS Institute 1996) and the means (n = 4 per treatment) compared using the Tukey-Kramer HSD means separation test (JMP, SAS Institute 1996) at alpha = 0.05.

Results

Cotesia marginiventris

The addition of carbohydrate sources had a significant effect on the longevity of *C. marginiventris* ($F = 49.49$; $df = 11$; $p < 0.0001$). The longevity was significantly different between wasps provided water ($\bar{x} \pm$ S.E; 4.0 ± 0.2; range 2-5 days) and those

provided honey (18.6 ± 1.6; range 3-33 days) and between wasps provided water and those provided sweet alyssum (19.4 ± 1.1; range 4-30 days) (Fig. 1). There was no significant difference in longevity between wasps provided with honey or sweet alyssum. Based on these results, *Cotesia marginiventris* survived on average approximately 4.8 times longer when provisioned with honey or sweet alyssum than with water alone.

Diadegma insulare

The addition of carbohydrate sources had significant effects on the longevity of *D. insulare* ($F = 74.66$; $df = 11$; $p < 0.0001$). The longevity was significantly different between wasps provided water ($\bar{x}$ ± S.E; 2.2 ± 0.3; range 1-4 days) and those provided honey (27.2 ± 1.0; range 2-51 days) and between wasps provided water and those provided sweet alyssum (27.3 ± 2.7; range 1-53 days) (Fig. 2). There was no significant difference in longevity between wasps provided honey and those provided sweet alyssum. Based on these results, *D. insulare* survived on average approximately 12.7 times longer when provisioned with honey or sweet alyssum than with water alone.

DISCUSSION

Providing a carbohydrate source in the form of honey or sweet alyssum to *C. marginiventris* and *D. insulare* extended their longevity well beyond that when provided water alone. There were no significant differences in the longevity of either *C. marginiventris* or *D.insulare* when caged with honey or with sweet alyssum flowers.

The longevity of wasps provided a nectar source in the field may not be as great as it was in the greenhouse, because environmental conditions are expected to be more severe. The longevity may vary even under greenhouse conditions, since the average longevity of *D. insulare* in this study was slightly higher than that of those provided honey or appropriate flowers in a previous study, also conducted in a greenhouse (Idris 1995). In addition to variations in environmental conditions, longevity may be affected by whether or not the female has been exposed to hosts (Hohmann et al. 1988).

Studies are planned which address the effects of sweet alyssum on biological control by *C. marginiventris* and *D. insulare* in commercial cabbage fields. Preliminary observations conducted in an experimental field plot and in a commercial cabbage field indicate that *D. insulare* does visit sweet alyssum flowers. Although a positive correlation was found between longevity and fecundity when fed appropriate nectar (Idris 1995), we will not know if this will translate into improved biological control by *D. insulare* or by *C. marginiventris* until field studies are completed. To test for increased parasitism in the field, we will plant areas of sweet alyssum in the field margins and record parasitism at various distances from the flowers throughout the season. Diamondback moth populations are highest in the field margins (Hu et al. 1997), and are particularly high in cooperating growers' fields because of their adoption of a collard trap crop technique in which collards, a favored host plant, are planted in the cabbage field peripheries (Mitchell et al. unpublished data).

In order to implement the planting of sweet alyssum in commercial cabbage in our area, we also will need to determine whether sweet alyssum is compatible with the current commercial cabbage growing operations, whether it flowers long enough and survives common agricultural practices, whether it will flower when necessary, whether it becomes weedy, and whether it may increase pest populations by providing food to adult moths. Preliminary observations indicate that sweet alyssum planted from seed in October started flowering as soon as three weeks after being planted, that it did not spread or become weedy, and that flowers persisted for approximately

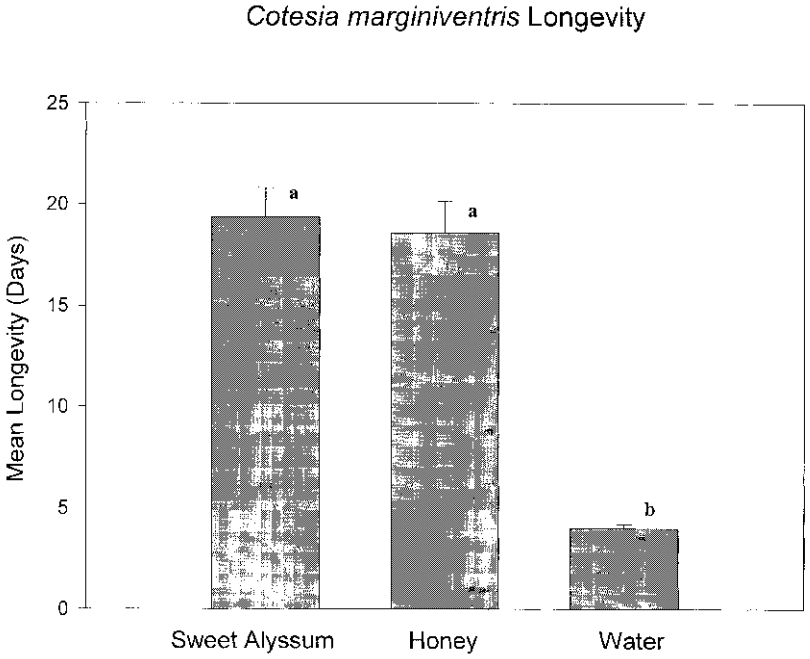

Fig. 1. Mean longevity of female *Cotesia marginiventris* provided sweet alyssum flowers, honey, or water alone. Error bars show S.E.M. Bars with same letter are not significantly different ($p < 0.05$).

5-6 months (March-April). Chaney (1998) reported that of all flowering plants tested in California as nectar sources for natural enemies of aphids, none bloomed as quickly as sweet alyssum or attracted as many desirable beneficial species while attracting relatively few pest species.

Based on the results of our study, on our preliminary observations, and on the results of Chaney (1998), we are encouraged to proceed with further studies of this tactic in commercial cabbage fields. Releases of *D. insulare* have been somewhat effective in managing the diamondback moth, and the addition of a food source for these and other released adult parasitoids shows promise as an improvement to augmentative biological control of lepidopteran pests in cabbage.

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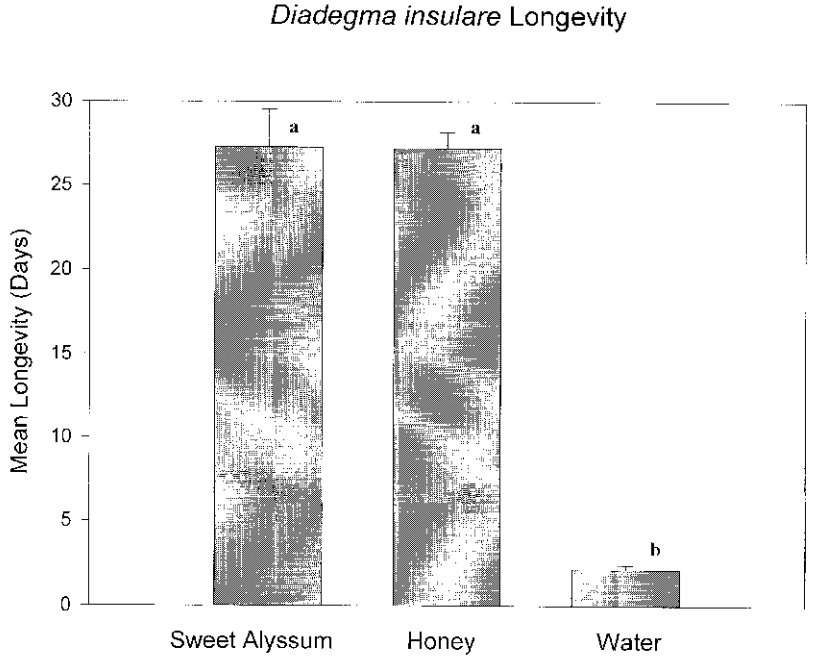

Fig. 2. Mean longevity of female *Diadegma insulare* provided sweet alyssum flowers, honey, or water alone. Error bars show S.E.M. Bars with same letter are not significantly different ($p < 0.05$).

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