PARASITISM OF *BEMISIA ARGENTIFOLII* ON COLLARD WITH REDUCED OR NORMAL LEAF WAX

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ABSTRACT

Collard, *Brassica oleracea* var. *acephala* L., cultivars with reduced leaf wax (i.e., glossy phenotypes) possess ovipositional antixenotic resistance to the silverleaf whitefly, *Bemisia argentifolii* Bellows & Perring (Homoptera: Aleyrodidae). We investigated parasitism by 2 parasitoids of *B. argentifolii* reared on 2 phenotypes of the collard cultivar 'Green Glaze', differing in amount of leaf wax. When *Eretmocerus* sp. (Hymenoptera: Aphelinidae) parasitoids were given a choice between parasitizing whitefly nymphs on glossy and normal-wax collard, there were no significant differences in the number of parasitized nymphs on the 2 plant phenotypes. However, 4.5 times more *Encarsia pergandiella* Howard (Hymenoptera: Aphelinidae) emerged from whiteflies on glossy than on normal-wax plants. In a no-choice test, the number of *Eretmocerus* sp. emerging on glossy and normal-wax plants did not differ significantly. In a similar no-choice test, more than twice as many *E. pergandiella* emerged from whiteflies on glossy collard than on normal-wax collard. Time to 50% emergence for whiteflies and both species of parasitoids did not differ on the 2 collard types in any of the no-choice tests. We conclude that management of *B. argentifolii* populations can be improved on collard, and probably other *B. oleracea* vegetables, through the use of reduced leaf wax cultivars that have antixenotic resistance to *B. argentifolii* and have no detrimental effects, possibly even beneficial effects, on important whitefly natural enemies.

Key Words: *Brassica oleracea,* plant resistance, *Eretmocerus, Encarsia pergandiella,* parasitoid, leaf wax, tritrophic interactions

RESUMEN

Cultivos de acelga, *Brassica oleracea* var. *acephala* L., con reducción de cera foliar (por ejemplo, fenotipos glaseados) poseen resistencia antixenotica oviposicional a la mosquita blanca, *Bemisia argentifolii* Bellows & Perring (Homoptera: Aleyrodidae). Investigamos el parasitismo por 2 parasitoides de *B. argentifolii* criados en 2 fenotipos del cultivo de acelga "Glaseado Verde", con diferencia en la cantidad de cera foliar. Cuando especies parasitoides de *Eretmocerus* (Hymenoptera: Aphelinidae) fueron dadas opción entre parasitar ninfas de mosquita blanca sobre acelga glaseada o con cera normal, no hubieron diferencias significativas en el numero de ninfas parasitadas de los 2 fenotipos de plantas. Sin embargo, emergieron 4,5 veces mas *Encarsia pergandiella* Howard (Hymenoptera: Aphelinidae) de mosquitas blancas en plantas glaseadas que en plantas con cera normal. En una prueba sin opción, el numero de especies de *Eretmocerus* emergiendo en plantas glaseadas y con cera normal no difirió significativamente. En una prueba similar sin opción, mas de 2 veces *E. pergandiella* emergieron de mosquitas blancas en acelga glaseada que en acelga de cera normal. El tiempo para 50% de surgimiento de mosquitas blancas y las dos especies de parasitoides no difirió en los 2 tipos de acelga en cualquiera de las pruebas sin opción. Concluimos que la administración de populaciones de *B. argentifolii* puede ser mejorada en acelga, y probablemente otros vegetales de *B. oleracea*, a través del uso de cultivos con

cera foliar reducida que tienen resistencia antixenotica a *B. argentifolii*, y que no tienen efectos perjudiciales, posiblemente hasta efectos beneficiosos, a importantes enemigos naturales de la mosquita blanca.

The silverleaf whitefly, *Bemisia argentifolii* Bellows & Perring, also known as the "B" strain of the sweetpotato whitefly, *Bemisia tabaci* (Gennadius), is a serious pest of vegetable, ornamental, and agronomic crops throughout tropical and, increasingly, temperate regions of the world. Cruciferous vegetables, such as collard, *Brassica oleracea* var. *acephala*, and broccoli, *B. oleracea* var. *italica*, are important overwintering hosts for *B. argentifolii* in the southern United States (Simmons & Elsey 1995) and are sources of infestation for spring and summer crops (Coudriet et al. 1985, Simmons & Elsey 1995). Reduction of whitefly populations in *Brassica* vegetables is desirable, not only to reduce the need for insecticides and prevent economic loss in these vegetables, but also to reduce spring whitefly populations available to infest newly planted crops.

Host plant resistance to *B. argentifolii* has been investigated in many crops. Leaf characteristics, such as trichome abundance and orientation (McCreight & Kishaba 1991, Kishaba et al. 1992, Wilson et al. 1993, Heinz & Zalom 1995, Lambert et al. 1995, McAuslane et al. 1995, McAuslane 1996), presence of glandular exudates (Liedl et al. 1995), and vascular bundle density (Cohen et al. 1996) and depth within the leaf (Chu et al. 1998, 1999), have been implicated in resistance to *B. argentifolii*. Recently, antixenotic resistance to whiteflies has been demonstrated in collard and broccoli genotypes that have reduced leaf wax (Farnham & Elsey 1995, Jackson et al. 2000). These genotypes have a glossy or shiny appearance due to their smaller wax load. Whiteflies preferred to oviposit on normal-wax genotypes; however, if offered no choice of oviposition host, whiteflies oviposited similar numbers of eggs and their progeny developed and survived equally well on glossy and normal-wax plants (Elsey & Farnham 1994, Jackson et al. 2000).

Bemisia argentifolii can suffer much mortality by natural enemies in many crops that are not sprayed extensively with broad-spectrum insecticides, such as peanut (McAuslane et al. 1993), organic vegetables (Stansly et al. 1997), and collard (Simmons & Jackson 2000). It is well known that plant characteristics can affect the behavior and physiology of the predators and parasitoids at the third trophic level (Price et al. 1980). For example, leaf hairs on cucumber (van Lenteren et al. 1995) and tomato (van Roermund & van Lenteren 1995) interfere with locomotion and parasitization efficiency of *Encarsia formosa* Gahan on *Trialeurodes vaporariorum* (Westwood). Hairs on soybean reduced parasitism of *B. argentifolii* by *Encarsia* and *Eretmocerus* species (McAuslane et al. 1995). Eigenbrode and colleagues (Eigenbrode et al. 1995, 1996, 1999) have demonstrated that several generalist predators control diamondback moth, *Plutella xylostella* L., more effectively on glossy cabbage cultivars and that this is due to more efficient locomotion and prey location behaviors on glossy than on normal-wax genotypes. Little is known, however, about the potential influence of leaf epidermal waxes on parasitoids of *B. argentifolii*.

The purpose of this research was to determine the potential effect of collard leaf wax on parasitoids of *B. argentifolii*. We selected one *Eretmocerus* species, a thelytokous undescribed species from Hong Kong (McAuslane & Nyugen 1996), and one *Encarsia* species, *Encarsia pergandiella* Howard, a common species native to the New World (Polaszek et al. 1992). We chose one species of each genus because of the different oviposition habits of the genera. *Encarsia* species oviposit through the nymphal host exoskeleton whereas *Eretmocerus* species insert the ovipositor between the whitefly nymph and the leaf surface. In this study, we measured parasitism by these parasitoids when presented whiteflies on normal-wax or glossy collard in no-choice and choice situations.

Materials and Methods

Plants and Insects

Seeds of 'Green Glaze' collard were obtained from M. W. Farnham (U.S. Vegetable Laboratory, Charleston, SC). This cultivar segregates in a 3:1 ratio for individual plants with either glossy (i.e., reduced foliar waxbloom) or normal-wax appearance (Jackson et al. 2000). Seeds were sown in a greenhouse in a soil-less medium (Metromix 200, Grace Sierra, Milpitas, CA). When seedlings could be distinguished as either glossy or normal-wax, they were transplanted into 12-cm-diameter pots filled with a 1:1 mixture of Metromix 200 and Metromix 500, and were fertilized with approximately 5 g of a slow-release fertilizer (14-14-14, N-P-K, Osmocote, Scotts-Sierra, Marysville, OH). Plants were used for experiments 5 to 9 weeks post-germination.

Whiteflies, *B. argentifolii*, used in experiments with *Eretmocerus* sp. were obtained from a colony reared on cotton, *Gossypium hirsutum* L., 'DPL 90', and collard, 'Georgia Southern', in a climate-controlled room (28°C, 14:10 [L:D] photoperiod, 30-50% RH). The thelytokous *Eretmocerus* sp. has been maintained on *B. argentifolii* on hibiscus, *Hibiscus rosa-sinensis* L., since it was introduced into the United States from Hong Kong in October 1992 (McAuslane & Nguyen 1996). Rearing conditions for *Eretmocerus* sp. were the same as those for *B. argentifolii. Bemisia argentifolii* used in experiments with *E. pergandiella* were from a colony maintained in a greenhouse on several vegetable species. The original feral adults were collected from a field of sweetpotato in Charleston Co., SC (Simmons 1994); feral adults from sweetpotato were added to the colony annually. An endemic population of *E. pergandiella* was maintained on *B. argentifolii* on several species of vegetables in a greenhouse. The parasitoids were collected at the same time as the whiteflies. The colony was occasionally supplied with cotton wicks soaked in 10% honey water.

Parasitism by *Eretmocerus* sp. in a no-choice test

Experiments with *Eretmocerus* sp. were conducted in an indoor climate-controlled room (28°C day/24°C night, 14:10 [L:D)], 30-50% RH) illuminated with high output 110-W cool- white fluorescent lights. Fifteen glossy and 15 normal-wax 6-week-old collard plants bearing 6 to 9 leaves were placed individually in plastic cylindrical cages (15 cm diameter × 30 cm high) with lids and 2 side openings screened with fine plastic mesh (94 × 94 mesh). The 2 oldest leaves were removed from each plant and then each cage was infested with 30 pairs of whiteflies. Whiteflies were removed after 72 hours. We assumed that whitefly oviposition on the 2 collard types was equal because the number of eggs laid on normal-wax and glossy collard is equal in no-choice situations (Elsey & Farnham 1994); however, we did not count whitefly eggs. Five female *Eretmocerus* were added to each cage 10 days later when whiteflies had developed to the first or second instar. Parasitoids were removed 24 hours later. When emergence began, newly-emerged whiteflies and parasitoids were aspirated from the plants and their exuvia were counted and removed from the leaves with a pin each day. This was continued until no further emergence was noted.

Parasitism by *Eretmocerus* sp. when presented a choice between glossy and normal-wax collard

Foraging behavior and plant preference was indirectly studied by allowing parasitoids a choice of glossy or normal-wax collard plants on which to forage for whitefly nymphs. Plants were 6 weeks old bearing 5 to 6 leaves. Four plants of the same phenotype were placed in a screened cage (70-mesh organdy fabric bag supported on a 60

cm × 60 cm × 60 cm plastic PVC-pipe frame) and were infested with 150 pairs of whiteflies. Whiteflies were removed 24 hours later. As in the previous experiment, we did not count whitefly eggs but assumed that there were similar numbers on glossy and normal-wax plants. The infested plants were then rearranged randomly among cages so that each screened cage contained 2 whitefly-infested glossy and 2 infested normal-wax plants. Ten cages were set up in this manner. Twelve female parasitoids were released into the center of each cage 11 days after adult whiteflies were removed when first and second instars were present. Parasitoids were not removed. Fifteen days later, leaves were cut from the plants and examined under a microscope. Whitefly exuvia and parasitized whitefly nymphs were counted on upper and lower surfaces of all leaves. Emergence of whiteflies and number of parasitized whiteflies were calculated on a per cage basis (= sum of whitefly exuvia or parasitized nymphs on 2 plants of the same genotype).

Parasitism by *E. pergandiella* in a no-choice test

Collard seeds were germinated in a greenhouse and then grown in an indoor temperature-controlled room under fluorescent lighting (40-W cool white and 40-W Vitalite® Duro-test® Power-Twist®). Upon reaching the 4-5 leaf stage, the plants were placed in an open greenhouse colony of *B. argentifolii*. Since whiteflies had a choice of ovipositing on normal-wax or glossy collard plants during the infestation procedure, normal-wax plants were exposed to whiteflies for 2 hours and glossy plants for 1 hour longer to compensate for reduced oviposition on the glossy collard. Exposure times were based on data obtained from field experiments (Jackson et al. 2000) and preliminary greenhouse studies (unpublished data). The plants were then moved from the colony and adult whiteflies were removed first by the air flow from an electrical fan and then with an aspirator. Two plants of each collard type were placed in a Plexiglass cage (45 cm wide × 45 cm long × 46 cm high) below fluorescent lamps (as described above) in a temperature-controlled room (14:10 L:D photoperiod supplying *ca.* 452 lux at plant height). Four cages per trial were set up. Temperature within the cages was 26-27°C. After the whiteflies developed to the second to third nymphal instar, all leaves below a single tagged target leaf (3-4 from bottom) were detached, as were any leaves younger than the targeted leaf that contained whitefly nymphs. Forty *E. pergandiella* (unsexed) were released into each cage. The parasitoids were retrieved with an aspirator after 24 hours. Upper and lower surfaces of the tagged leaves were checked daily for whitefly or parasitoid emergence. Any adults and exuvia observed were removed daily, and exuvial counts were recorded. This was continued until no further emergence was noted. The experiment was repeated to obtain a second trial. Emergence of whiteflies and parasitoids was calculated on a per cage basis (= sum of emergence on 2 plants of the same genotype).

Parasitism by *E. pergandiella* when presented a choice between glossy and normal-wax collard

Collard plants at the 5- to 6-leaf stage were infested during a 12-14 hour exposure to whiteflies in a greenhouse. The adult whiteflies were removed using an aspirator and then the plants were transferred to a temperature-controlled room. One glossy and one normal-wax plant were placed in a Plexiglass cage (45 cm wide × 45 cm long × 46 cm high) and 8 replicate cages were set up. Forty parasitoids (unsexed) were added to each cage when whiteflies had developed to the second or third nymphal instar. After 3 weeks, exuvia from which either a whitefly or a parasitoid emerged were counted.

Statistical Analyses

We compared whitefly emergence, parasitoid emergence, and number of parasitized nymphs between glossy and normal-wax collard using analysis of variance (PROC GLM; SAS Institute 1997). Because only a small percentage (<5%) of immature whiteflies develop on the top leaf surface of collard (Simmons 1994) and leaf surface does not affect development (Simmons 1999), emergence data were pooled between leaf surfaces. Data for emerged whiteflies and parasitoids or parasitized nymphs were log (x + 0.1)-transformed, when necessary, to correct for variance increasing with the mean. Means shown in tables are untransformed. We compared developmental time of whiteflies and parasitoids between the 2 collard types by estimating time to 50% emergence on each plant using linear regression (PROC REG; SAS Institute 1997) and performing analysis of variance (PROC GLM) on estimated times to 50% emergence. Significant least square means were separated by the probability of a significant difference at = 0.05 (PROC GLM).

RESULTS

Parasitism by *Eretmocerus* sp.

In the no-choice test, one plant which was initially classified as a normal-wax collard was in fact glossy and another normal-wax collard was destroyed during the experiment leaving 13 replicate normal-wax collard plants and 16 glossy collard replicates. Whiteflies emerged over a 15-day period beginning 21 days after the plants were infested. The time to 50% emergence of whiteflies did not differ on the 2 collard wax types ($F_{(1, 12)} = 0.11$; $P = 0.75$) and averaged 4.4 ± 0.8 days (mean ± se), with the first day of whitefly emergence being day 1. *Eretmocerus* parasitoids emerged over an 11-day period, beginning on day 13 of whitefly emergence. The time to 50% emergence of parasitoids did not differ between the 2 collard types ($F_{(1, 12)} = 0.41$; $P = 0.53$) and averaged 4.4 ± 0.3 days. The number of parasitoids emerging was not influenced by collard type ($F_{(1, 11)} = 1.48$; $P = 0.25$) nor was whitefly emergence ($F_{(1, 12)} = 1.69$; $P = 0.22$) (Table 1).

In the choice test, neither whitefly emergence ($F_{(1, 9)} = 0.24$; $P = 0.63$) nor the number of parasitized nymphs ($F_{(1, 8)} = 0.92$; $P = 0.37$) differed significantly between normal-wax and glossy collard (Table 1).

Parasitism by *E. pergandiella*

In the no-choice test, whiteflies emerged over a 13-day period in trial 1 and an 11-day period in trial 2. Time to 50% emergence was not influenced by collard type ($F_{(1, 7)} = 0.04$; $P = 0.86$), but there was a significant effect of trial ($F_{(1, 7)} = 13.06$; $P = 0.009$). Time to 50% emergence of whiteflies was 4.7 ± 0.4 days in trial 1 and 2.2 ± 0.7 days after first whitefly emergence in trial 2. *Encarsia pergandiella* emerged over a 12-day period in trial 1 and an 8-day period in trial 2, but there was no significant effect of collard type ($F_{(1, 4)} = 0.31$; $P = 0.61$) or trial ($F_{(1, 4)} = 0.06$; $P = 0.82$) on time to 50% emergence, which averaged 3.8 ± 0.5 days after the first parasitoid emerged.

Whitefly emergence was influenced by trial ($F_{(1, 6)} = 33.91$; $P = 0.001$), collard type ($F_{(1, 6)} = 12.00$; $P = 0.013$), and the interaction of trial × collard type ($F_{(1, 6)} = 14.05$; $P = 0.0095$). Significantly more whiteflies emerged from glossy collard in trial 1 than from normal-wax collard (Table 2). Emergence did not differ in trial 2. Emergence of *E. pergandiella* was significantly influenced by trial ($F_{(1, 12)} = 5.39$; $P = 0.039$) and collard type

TABLE 1. NUMBER OF EMERGED *ERETMOCERUS* SP. PARASITOIDS AND WHITEFLIES ON GLOSSY AND NORMAL-WAX 'GREEN GLAZE' COLLARD IN NO-CHOICE AND CHOICE TESTS (MEANS ± SE, RANGE).

Wax type	No. *Eretmocerus* emerged	No. whiteflies emerged
	No-choice test	
Glossy	36.0 ± 6.3 (0 - 74)	134.8 ± 24.0 (19 - 439)
Normal-wax	24.2 ± 3.8 (5 - 47)	168.2 ± 29.5 (28 - 408)
	Choice test	
Glossy	88.5 ± 12.3 (36 - 160)	940 ± 211 (382 - 2644)
Normal-wax	97.9 ± 11.4 (45 - 166)	937 ± 206 (415 - 1565)

($F_{(1,12)} = 11.38$; $P = 0.006$), but there was no trial × collard type interaction ($F_{(1,12)} = 0.15$; $P = 0.71$). More than twice as many parasitoids emerged from glossy plants than from normal-wax plants (an average of 35.5 ± 4.8 vs. 14.6 ± 5.0 per plant, respectively) (Table 2).

In the choice test, there was no significant difference in whitefly emergence on the 2 collard types ($F_{(1,7)} = 0.01$; $P = 0.93$) (Table 2). However, 4 times as many *E. pergandiella* emerged from glossy collard than from normal-wax collard ($F_{(1,6)} = 23.87$; $P = 0.003$).

DISCUSSION

The glossy leaf-wax trait in *Brassica* vegetables has been associated with resistance to several important insect pests such as the cabbage aphid, *Brevicoryne brassicae* (L.), the imported cabbageworm, *Artogeia rapae* (L.), *P. xylostella* (Eigenbrode & Shelton 1990, Stoner 1990, Eigenbrode et al. 1991), and *B. argentifolii* (Elsey & Farnham 1994, Farnham & Elsey 1995, Jackson et al. 2000). In the case of *P. xylostella*, reduced pest populations on glossy plants were due partly to the direct physical and allelochemical effects on the insect of leaf wax components (Eigenbrode et al. 1991), and partly to enhanced predation by natural enemies (Eigenbrode et al. 1995). Eigenbrode et al. (1995) stated that the importance of predation should be evaluated during development of glossy *Brassica* for resistance to insects.

Our study indicates that parasitism of whitefly nymphs by *E. pergandiella* is enhanced on glossy phenotype 'Green Glaze' collard compared with a normal-wax phenotype. These phenotypes are isogenic except for the single gene mutation causing glossiness, hence, we would not expect any nutritional effects of the plant acting through the host on the parasitoid. We did not find the same increase in whitefly parasitism by *Eretmocerus* sp. on glossy collard. However, and of more importance to regulation of whitefly populations, we saw no decrease in parasitism by *Eretmocerus* sp. on glossy collard.

We had expected, given the nature of the oviposition behavior of these 2 parasitoid species, that *Eretmocerus* sp. would be more affected, either negatively or positively, by

TABLE 2. NUMBER OF EMERGED *E. PERGANDIELLA* PARASITOIDS AND WHITEFLIES ON GLOSSY AND NORMAL-WAX 'GREEN GLAZE' COLLARD IN NO-CHOICE AND CHOICE TESTS (MEANS ± SE, RANGE).

Wax type	No. *E. pergandiella* emerged	No. whiteflies emerged
	No-choice test	
Trial 1		
Glossy	41.5 ± 5.7a[1] (32 - 58)	711 ± 108a (433 - 946)
Normal-wax	23.0 ± 7.3ab (8 - 42)	266 ± 38b (154 - 318)
Trial 2		
Glossy	29.5 ± 7.1a (13 - 47)	120 ± 13b (96 - 150)
Normal-wax	6.25 ± 4.0b (1 - 18)	137 ± 14b (101 - 170)
	Choice test	
Glossy	89.0 ± 19.4a (23 - 195)	135.6 ± 24.8 (52 - 270)
Normal-wax	19.8 ± 4.4b (2 - 44)	160.4 ± 47.6 (27 - 418)

[1]Means within a column and within a test followed by different letters differ significantly (probability of a significant difference of least squares means, $\alpha = 0.05$).

collard leaf wax because *Eretmocerus* sp. females must locate a suitable gap between the whitefly nymph and the leaf surface through which to insert their ovipositor. If the marginal wax laid down by whitefly nymphs adheres differently on normal-wax and glossy plants, we might expect the ability of *Eretmocerus* sp. to insert its ovipositor to be different on the 2 plant types. On the other hand, *E. pergandiella* females oviposit through the dorsum of their host and the adhesion of the host to the leaf should not influence oviposition success. The eggs of *Eretmocerus* species, in general, lie underneath the host on the leaf surface for several days before the first instar parasitoid ecloses and chews into the whitefly nymph (Foltyn & Gerling 1985, McAuslane & Nyugen 1996). The egg is presumably in contact with leaf waxes and allelochemicals and could be influenced by physical and chemical characteristics of this wax layer. *Encarsia pergandiella* immature stages are never in direct contact with the leaf surface. In our study, contrary to our expectations, we found that parasitism of whitefly by *E. pergandiella* was in fact improved on the glossy collard while parasitism success of *Eretmocerus* was unchanged. Reasons other than those proposed above must account for the different parasitism success of these two species on glossy and normal-wax collard.

Large-bodied generalist predators of diamondback moth, such as adults of *Orius insidiosus* (Say) and *Hippodamia convergens* Guerin-Meneville, and larval *Chrysoperla carnea* (Stephens) are more mobile on glossy cabbage genotypes (Eigenbrode et al. 1996) and consequently locate *P. xylostella* larvae better on glossy cabbage than on normal-wax cabbage (Eigenbrode et al. 1995). Their greater mobility is due to the fact

that they spend less time scrambling (i.e., slipping while walking), falling off the plant, and grooming off wax particles that had accumulated on their tarsi on glossy cabbage than on normal-wax cabbage (Eigenbrode et al. 1996). Much of the reason that predators can move more efficiently on glossy genotypes is because they can generate much greater adhesive force on glossy leaves than on normal-wax cabbage leaves (Eigenbrode et al. 1999). Aphelinid parasitoids fly from plant to plant when foraging for whitefly hosts and often fly within the plant, from leaf to leaf. Parasitoids do, however, walk extensively on the leaf searching for host patches. It is not known whether these very small-bodied hymenopterans suffer the same reduced traction on normal-wax plants as do larger predators. This aspect of parasitoid behavior needs to be studied more carefully.

Other possible reasons for the difference in parasitism of *Eretmocerus* and *E. pergandiella* are potential differences in whitefly nymph distribution on leaves. If whitefly oviposition behavior differs on glossy and normal-wax collard, leading to different dispersion of nymphs, this may differently affect the foraging behavior and parasitization success of these 2 parasitoid species. Finally, although we tried to perform experiments under similar environmental conditions, *Eretmocerus* and *E. pergandiella* were studied in different laboratories. It is known that water saturation and other environmental conditions can alter the composition and amount of leaf waxes (reviewed in Eigenbrode & Espelie 1995). This may have affected parasitoid behavior and/or survival.

Host plant resistance and biological control have long been considered the cornerstones of pest management strategies. While generally thought to be compatible and additive in nature (Bergman & Tingey 1979), these tactics have not always been so. We have demonstrated that the nonpreference ovipositional resistance (antixenosis) in glossy collards to *B. argentifolii* is fully compatible with biological control by species in the 2 most important genera of whitefly parasitoids. Parasitism of whiteflies is at least as high, if not higher in the case of *E. pergandiella*, on a glossy collard phenotype compared with that on a normal-wax phenotype. Use of glossy collard in a management program that includes natural enemies should lead to smaller whitefly infestations in collard, leading to a reduced need for insecticide application and reduced populations infesting spring plantings of other crops.

Acknowledgments

The authors thank D. Boyd, J. Squitier, and Y. Cardoza (University of Florida, Gainesville, FL), and J. Bhamoo, B. Davis, J. Day, L. Cauthen, and J. Cook (USDA ARS, Charleston) for assistance with experiments and rearing of insects and plants. Thanks also to G. S. McCutcheon (Clemson University, Charleston, SC) and T.-X. Liu (Texas A&M University, Weslaco, TX) for providing valuable comments on an earlier version of this manuscript. This article is from a cooperation between the University of Florida and the U.S. Vegetable Laboratory, USDA, Agricultural Research Service. Funding was provided by Experiment Station Project FLA-ENY-03194 and the U.S. Vegetable Laboratory. It is published with the approval of both agencies as Florida Agricultural Experiment Station Journal Series No. R-07369. Mention of a proprietary product does not constitute an endorsement or recommendation by the USDA for its use.

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