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EFFECTS OF AUGMENTING POPULATIONS OF PREDACIOUS INSECTS ON APHID AND WHITEFLY PESTS OF MUSKMELON

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Abstract. **Melon aphid (*Aphis gossypii* Glover) and silverleaf whitefly (*Bemisia argentifolii* Bellows and Perring [= B strain of *Bemisia tabaci* (Gennadius)]) are major pests of cucurbits. An early infestation of melon aphid on muskmelon (*Cucumis melo* L.) can lead to severe damage to new growth, stunting, and yield loss. Heavy whitefly populations also contribute to poor growth of young plants. Early in the season, natural populations of insect predators may be low, and artificially increasing the population with insectary-reared predators might keep pest populations from reaching damaging levels. Two predacious insects, pink spotted lady beetle (*Coleomegilla maculata* DeGeer) and a bigeyed bug [*Geocoris punctipes* (Say)], were released onto muskmelon, cv. 'Athena', that had been infested with aphids. Whiteflies infested the crop from nearby potatoes. Immature stages of predators were used to prevent their dispersal from the release site. Within a week of the release, aphid populations declined sharply in all treatments. A lady beetle (*Coccinella septempunctata* L.) that moved into the melons when the adjacent potato vines were killed may have been responsible. Pink spotted lady beetle larvae matured and dispersed. Bigeyed bugs persisted for the rest of season. Whitefly populations were higher on plants infested with the highest rate of bigeyed bugs. It is possible that these predators interfered with other naturally occurring predacious insects. Instead of releasing additional predators, it might be more economical to plant an earlier, unrelated crop to generate natural enemies for a second crop and conserve naturally occurring predators by avoiding broad-spectrum insecticides.**

Muskmelon (*Cucumis melo* L.) is a high value cucurbit that is becoming increasingly important in Florida with the development of varieties adapted to the Southeast. It suffers leaf distortion and stunting under heavy aphid pressure (Webb, 1996). Although it is not susceptible to whitefly-induced leaf silvering, muskmelon plants can suffer damage from high populations of whiteflies [*Bemisia argentifolii* Bellows and Perring = *Bemisia tabaci* (Gennadius)]. In Arizona and Texas, high populations of whiteflies significantly reduced yield and quality of muskmelon (Riley and Palumbo, 1995).

Aphids and whiteflies can be serious pests of many vegetables, including cucurbits (Capinera, 2001). Both pests reproduce rapidly, building to damaging levels in a short time. Naturally occurring insect parasitoids and predators may not increase quickly enough to prevent damage to the crop. If augmentation with predacious insects early in the season provided a significant level of control, growers might be able to avoid broad-spectrum pesticides and use softer materials, such as *Bacillus thuringiensis* for control of caterpillar pests on the same crops. Naturally occurring beneficial insects would thus be preserved, enhancing control of all potential pests. The purpose of this work was to determine if insectary-reared general predators released on plants in the field as immatures could reduce populations of aphids and whiteflies.

Specifically, we compared two release rates of pinkspotted lady beetle (*Coleomegilla maculata* DeGeer) and a bigeyed bug [*Geocoris punctipes* (Say)]. Pinkspotted lady beetle is an important predator of aphids, including melon aphid, although it will also feed on insect eggs, small larvae, and mites (Hoffman and Frodsham, 1993). Bigeyed bug is known as a predator of whiteflies, mites, insect eggs, and small caterpillars (Hagler, 2004) but is not very effective for control of melon aphid (Rosenheim and Wilhoit, 1993). It is now commercially available (e.g., http://store.arbico-organics.com/1116201.html, http://www.rinconvitova.com.). The release rate recommended by Rincon-Vitova Insectaries (Ventura, Calif.) for bigeyed bugs is 250,000 per acre. Preliminary laboratory data from Entomos (Gainesville, Fla.), the producer of our predators, suggested a ratio of 1 predator for every 10 or 20 prey (12,000 to 24,000 per acre with a plant density of 3,000 per acre).

Materials and Methods

The field experiment was designed as a randomized complete block with four replications. Muskmelon, cv. 'Athena' (Agrisales, Inc., Plant City, Fla.), was direct-seeded on 12 Apr. (blocks 1 through 3) and 13 Apr. (block 4) at the Hastings Research and Education Center Yelvington Research Farm, Hastings, Fla. Each replicate plot consisted of four rows, 25 ft long, with plants spaced 2.5 ft apart within the row. Rows within plots were 80 inches apart. Plots were separated from each other by 15 ft of bare ground. Soil type was an Ellzey fine sand having approximately 91.7% sand, 5.6% silt, and 2.7% clay, pH 5.5-6.0.

Herbicide (ethalfluralin; Dow AgroSciences LLC, Indianapolis, Ind.) was applied after planting. Plots were thinned to one plant per hill on 2 May. Water was supplied by seepage irrigation as needed. Fertilization and other cultural practices were performed according to University of Florida Extension guidelines (Maynard et al., 2003). Beginning on 4 May (but skipping 11 May), azoxystrobin (Syngenta Crop Protection, Greensboro, N.C.) was alternated with chlorothalonil (Syngenta) on a 7-d schedule for control of fungal diseases, using label rates.

Treatments included an untreated check, two conventional treatments [imidacloprid (Bayer CropScience, Research Triangle Park, N.C.) at 16 oz/acre applied at planting and pymetrozine (Syngenta) at 2.75 oz/acre applied on 17 May], two release rates of ladybird beetle larvae and two release rates of bigeyed bug nymphs (one predator per 10 aphids and one per 20 aphids). Immature insects were used because they lack wings and would be more likely than adults to remain near the release site.

The aphid population was augmented before releasing natural enemies. Melon aphids (*Aphis gossypii* Glover) were

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collected from the University of Florida, Horticultural Sciences Department demonstration greenhouse and used to start an aphid colony. Each aphid produced approximately 10 nymphs per day over several days. These newborn aphids were transferred to squash (*Cucurbita pepo* L.) plants in a cage. Once these aphids were well established, they and their offspring were distributed on 30 squash plants in a greenhouse. Aphids were protected from parasitoids and predators by floating row covers placed over the plants after infestation. After 3 weeks, squash plants with aphids were transported to Hastings when muskmelon plants in the field plots had three to four true leaves (11 May). Pieces of squash leaf with 20 to 50 aphids were placed on each cantaloupe plant.

On 16 May, we counted all aphids on five plants per plot. The overall average number of aphids per plant in the plots destined to receive natural enemies was 89. Because the number of predators available was limited, we reduced the number of plants in each plot to 20, in order to approximately maintain the planned release rates of one predator per 10 aphids and one predator per 20 aphids. On 17 May, with the assistance of Kim Gallagher of Entomos, we released either four or eight predators per plant according to the particular treatment. We observed other natural enemies, including sevenspotted lady beetle (*Coccinella septempunctata* L.) and insidious pirate bugs [*Orius insidious* (Say)], on plants as well as adult silverleaf whiteflies and a few small cabbage loopers [*Trichoplusia ni* (Hübner)]. We applied pymetrozine, which is specific for aphids and whiteflies, using a backpack sprayer (15 gal/acre), to plants in the foliar insecticide treatment.

Evaluation. Beginning on 23 May, aphids were counted weekly for 5 weeks on 20 leaves of similar size collected from the inner rows of each plot. Immature whiteflies and whitefly eggs were counted on three leaf disks cut from each of the 20 leaves with a cork borer (total area per leaf = 1.0 inch^2). Any predators noted on the 20 leaves were recorded.

We harvested melons on 3 and 6 July. Melons were counted and then weighed. Numbers and weights for both dates were combined before analyzing data.

Data analysis. All data were analyzed using SAS software for the Macintosh. Analysis of variance (using PROC GLM) and a mean separation test (Waller Duncan *k*-ratio) were used to detect differences among treatments. A log transformation was used to stabilize variance of insect counts. Non-transformed means are shown in the tables.

Results and Discussion

Insect counts. Potato (*Solanum tuberosum* L.) vines in commercial fields surrounding the experimental plots were killed with herbicide by the grower shortly after predators were released onto melon plants. Sevenspotted lady beetles (*C. septempunctata* L.) from the potato crop migrated to the melon planting. When we examined melon plants 6 d after the release, there were very few aphids on any plants, even on those in the untreated check. We suspect that the sevenspotted lady beetles, which were abundant, had contributed to the decline in aphids.

There were no significant differences among treatments in the number of apterous (wingless) aphids per leaf, even on 23 May (Table 1). By 6 June, no more aphids were found. Although the differences are not significant, the number of aphids on the plants receiving four predators was twice as high as on those receiving eight. Thus, despite the presence of the sevenspotted lady beetles, there was a trend toward better control with the 1:10 ratio of predator to aphids.

Table 1. Apterous aphids per leaf (n = 80).

		Date		
Treatment	Rate	23 May	30 May	6 June
Imidacloprid	16 oz/acre	0.14[z]	0.00	0.00
Check		0.50	0.00	0.00
Pymetrozine	2.75 oz/acre	0.20	0.00	0.00
Bigeyed bug	four per plant	0.54	0.00	0.00
Bigeyed bug	eight per plant	0.25	0.01	0.00
Lady beetle	four per plant	0.94	0.00	0.00
Lady beetle	eight per plant	0.42	0.00	0.00

[z]Mean separation in columns by Waller-Duncan *k*-ratio test, *k* = 100 (ca. 5% level).

Adult and immature insidious pirate bugs, spiders, and all lady beetles found on collected leaves were counted, although this was not the best way to estimate the numbers of these highly mobile insects. More insidious pirate bugs were found on leaves collected from imidacloprid-treated plants (Table 2). Few spiders and lady beetle larvae were detected in leaf samples and there were no differences among treatments (data not shown). After the first sample date, neither larvae nor adults of the released lady beetles were observed at the time of leaf collection. Pink spotted lady beetle requires plant pollen in its diet in addition to insects (Hoffman and Frodsham, 1993), and there were few flowering plants within the melon plots. Bigeyed bug nymphs and adults, which will feed on plants when prey is not available (Hagler, 2004), were present throughout the study. It was not possible to tell if these bugs were the descendents of the original release or a wild population.

Whiteflies were more abundant than aphids. On 23 May, there were many fewer eggs on the insecticide-treated plants (all differences between means reported below were significant at the 5% level, Waller-Duncan), but no differences were found between any of the predator treatments and the untreated check (Fig. 1). This was true for the 30 May sample as well. By 6 June, however there were more whitefly eggs on plants that initially had a 1:20 lady beetle:aphid ratio. By 13 June, the effects of pymetrozine had diminished, and both of the high rate predator treatments had more eggs than the check. By 20 June, plants from both of the bigeyed bug treatments and the low rate of lady beetles had more eggs than the untreated plants.

Table 2. Insidious pirate bug (adults and nymphs) per leaf (n = 80).

		Date		
Treatment	Rate	23 May	30 May	6 June
Imidacloprid	16 oz/acre	0.18 a[z]	0.00	0.08
Check		0.05 bc	0.03	0.14
Pymetrozine	2.75 oz/acre	0.01 c	0.00	0.08
Bigeyed bug	four per plant	0.00 c	0.00	0.05
Bigeyed bug	eight per plant	0.06 bc	0.00	0.10
Lady beetle	four per plant	0.04 bc	0.00	0.14
Lady beetle	eight per plant	0.09 b	0.00	0.13

[z]Mean separation in columns by Waller-Duncan *k*-ratio test, *k* = 100 (ca. 5% level).

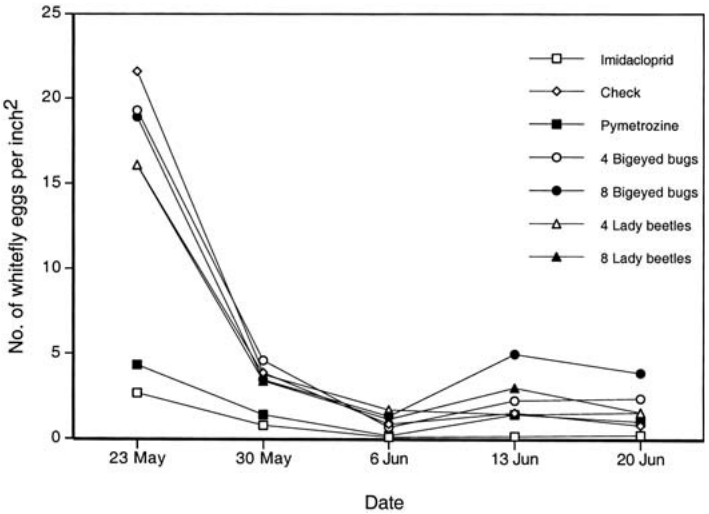

Fig. 1. Number of whitefly eggs per inch² of muskmelon leaf.

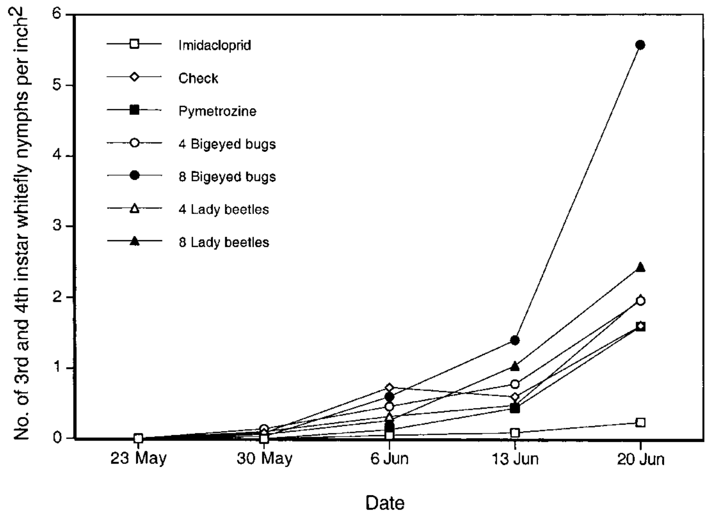

Fig. 3. Number of third and fourth instar whitefly nymphs per inch² of muskmelon leaf.

A similar pattern was evident for small whitefly nymphs (first and second instars) (Fig. 2). No differences were found on 23 May when the population was still low. By the second date, only the plants from insecticide treatments had fewer nymphs than the untreated plants. On 6 June, however, all treatments had fewer nymphs than the untreated check. By 13 June, pymetrozine was no longer effective and only imidacloprid-treated plants had fewer nymphs than the untreated check. In contrast, plants receiving the highest rate of bigeyed bugs had more nymphs than the check. On the final sample date, plants from both bigeyed bug treatments had more nymphs than the untreated plants. Imidacloprid was still effective over two months after application.

Late instar whitefly nymphs increased a week after the early instars and differences were found by 6 June (Fig. 3). This time, in addition to the insecticide treatments, plants receiving lady beetles had fewer late instar nymphs than the untreated check. By 13 June, only imidacloprid-treated plants had fewer nymphs than the check, and plants from the high rates of bigeyed bugs and lady beetles had more nymphs. On 20 June, imidacloprid was still effective and plants from both rates of bigeyed bugs and the high rate of lady beetles had more nymphs that the untreated check.

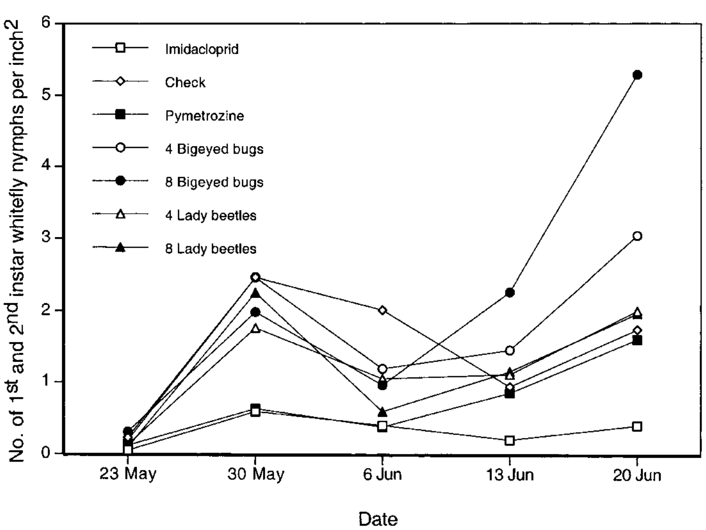

Fig. 2. Number of first and second instar whitefly nymphs per inch² of muskmelon leaf.

Yield. Muskmelon yields did not differ among treatments (data not shown), which suggests that, even in the plots with the greatest numbers of whiteflies, populations did not reach levels high enough to cause yield reductions.

To explain the higher whitefly population in the plots where predators were released, we speculate that the predators we introduced upset some local natural enemy of the whiteflies, possibly insidious pirate bug. Plots in which we released bigeyed bugs had the most dramatic differences by the end of the season. The lady beetle specie that we released is primarily an aphid predator and it is not clear how it may have interfered with natural control of whiteflies, especially because it disappeared early in the season.

Predacious insects, especially those that feed on a variety of prey, can interfere with each other (Symondson et al., 2002). Most commonly, the introduced predator is preyed upon by existing predacious insects (reviewed by Symondson et al., 2002). In a field study, nymphal bigeyed bugs were one of several general predators observed feeding on lacewing larvae that were released in cotton (*Gossypium hirsutum* L.) to control cotton aphid (*Aphis gossypii* Glover; called melon aphid on cucurbits). In further cage studies, bigeyed bug did not significantly interfere with aphid control by lacewings (*Chrysoperla* spp.), unlike assassin bugs (*Reduviidae*), which had a major impact (Rosenheim and Wilhoit, 1993). In another study (Heinz et al., 1999), a coccinellid beetle released in cotton to control silverleaf whitefly was attacked by several naturally occurring predacious insects, including bigeyed bugs, which fed on the eggs of the beetle.

With a few exceptions, augmentative releases of predacious insects have had limited success (Symondson et al., 2002). During the course of our experiment, we observed a variety of insect natural enemies, both predators and parasitoids. Conserving these existing biological control agents by choosing the least harmful insecticides and applying them only when needed to prevent economic damage may be the most economical approach to integrated pest management in commercial muskmelon production in Florida. In this study, even our untreated plants did not suffer serious damage from aphids and whiteflies.

Literature Cited

Capinera, J. L. 2001. Handbook of vegetable pests. Academic Press, San Diego.

Hagler, J. 2004. *Geocoris* spp. (Heteroptera: Lygaeidae), bigeyed bug. In C. R Weeden, A. M. Shelton, Y. Li, and M. P. Hoffman (eds.). Biological control: A guide to natural enemies in North America, Cornell University, http://nysaes.cornell.edu/ent/biocontrol/predators/geocoris.html.

Heinz, K. M., J. R. Brazzle, M. P. Parella, and C. H. Pickett. 1999. Field evaluation of augmentative releases of *Delphastus catalinae* (Horn) (Coleoptera: Coccinellidae) for suppression of *Bemisia argentifolii* Bellows and Perring (Homoptera: Aleyrodidae) infesting cotton. Biol. Control 16:241-251.

Hoffman, M. P. and A. C. Frodsham. 1993. Natural enemies of vegetable insect pests. Cornell University, Ithaca, NY.

Maynard, D. N., G. J. Hochmuth, C. S. Vavrina, W. M. Stall, T. A. Kucharek, S. E. Webb, T. G. Taylor, S. A. Smith, E. H. Simonne, and S. M. Olson. 2003. Cucurbit production in Florida. p. 153-180. In S. M. Olson and E. Simonne (eds.). Vegetable production guide for Florida, 2003-2004. SP 170. Univ. of Fla. Coop. Ext., Gainesville and Vance Publ., Lenexa, KS.

Riley, D. G. and J. C. Palumbo. 1995. Interaction of silverleaf whitefly (Homoptera: Aleyrodidae) with cantaloupe yield. J. Econ. Entomol. 88:1726-1732.

Rosenheim, J. A. and L. R. Wilhoit. 1993. Predators that eat other predators disrupt cotton aphid control. Calif. Agr. 47(5):7-9.

Symondson, W. O. C., K. D. Sunderland, and M. H. Greenstone. 2002. Can generalist predators be effective biological control agents? Annu. Rev. Entomol. 47:561-594.

Webb, S. E. 1996. Management of melon aphid on muskmelon and watermelon with insecticides specific for Homoptera. Proc. Fla. State Hort. Soc. 109:202-205,