ASSESSMENT OF BIOLOGICAL CONTROL OF *BEMISIA TABACI* (HOMOPTERA: ALEYRODIDAE) ON COMMON BEAN IN HONDURAS

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ABSTRACT

Two experimental field trials assessed the effect of natural enemies on immature stages of *Bemisa tabaci* (Gennadius) infesting two varieties of common bean (*Phaseolus vulgaris* L.), 'Dorado 364' (Bean Golden Mosaic Virus (BGMV) tolerant) and 'Catrachita' (BGMV susceptible). Studies were carried out at Zamorano, Honduras during 'primera' (May-August) 1995 and 'postrera' (September-January), 1995-96. Treatments corresponded to two types of exclusion cages ($1 \times 1 \times 0.5$ m) and a no cage treatment. Cages were covered with organdy to exclude all natural enemies or with a net material to exclude larger predators but allow smaller parasitoids to enter the cages.

Percentage parasitism ranged from 21 to 32% in 'primera' and from 10 to 37% in 'postrera'. The nymphal density of *B. tabaci* was relatively low and ranged from 2 to 7 nymphs per leaf in 'primera' and between 0.4 to 0.9 nymphs per leaf in 'postrera'. The most common parasitoids collected from *B. tabaci* were *Encarsia pergandiella* Howard and *E. nigricephala* Dozier (Aphelinidae). Our results suggest that parasitism is host-density independent. Parasitism at low host densities (< 1 nymph per leaf) may be a contributing factor preventing *B. tabaci* outbreaks.

Key Words: Bemisia, parasitoids, predators, Zamorano

RESUMEN

Dos experimentos evaluaron el impacto de enemigos naturales sobre estados inmaduros de *Bemisia tabaci* (Gennadius) atacando dos variedades de frijol común (*Phaseolus vulgaris* L.), 'Dorado 364' (tolerante al Virus del Mosaico 'Dorado' del Frijol, VMDF) y 'Catrachita' (susceptible al VMDF). Los estudios se hicieron en la Escuela Agrícola Panamericana, Zamorano, Honduras durante la 'primera' (Mayo-Agosto) y la 'postrera' (Septiembre-Enero), 1995-96. Los tratamientos fueron dos tipos de jaulas de exclusión ($1 \times 1 \times 0.5$ m) y un tratamiento sin jaula. Las jaulas fueron cubiertas con organza, para excluir todos los enemigos naturales o con tela punto (malla), para excluir depredadores pero permitir la entrada de parasitoides.

El porcentaje de parasitismo varió entre 21 y 32% en la 'primera' y entre 10 y 37% en la 'postrera'. La densidad de ninfas fue relativamente baja y varió entre 2 y 7 ninfas por hoja en la 'primera' y entre 0.4 y 0.9 ninfas por hoja en la 'postrera'. Los parasitoides mas comunmente recolectados fueron *Encarsia pergandiella* Howard y *E. nigricephala* Dozier (Aphelinidae). Nuestros resultados sugieren que el parasitismo no está directamente relacionado con la abundancia del hospedero. El parasitismo a bajas densidades del hospedero (menos de una ninfa por hoja) puede ser un factor que contribuye a la prevención de explosiones poblacionales de *B. tabaci*.

In recent years *Bemisia tabaci* (Gennadius) (Homoptera: Aleyrodidae) has become a major pest of beans in Honduras (Caballero 1995) and other countries of Latin America (Galvez & Morales 1989). Whitefly problems have historically occurred after the introduction of intensive cropping systems with high inputs of fertilizers and pesticides (Brown et al. 1995). This and the possible introduction of the more damaging *B. tabaci* biotype B have caused a change in pest status from sporadic to major pest in many crops including the common bean.

Bemisia tabaci is a vector of several plant viruses, e.g., bean golden mosaic virus (BGMV) and bean dwarf mosaic virus (BDMV) that reduce bean yields in Latin America (Galvez & Cardenas 1980, Brown & Bird 1995). The use of tolerant varieties and the adoption of cultural practices to reduce the likelihood of colonization by *B. tabaci* are among the few alternatives available to small scale farmers who cannot afford insecticides. Biological control of disease vectors, including *B. tabaci*, through the conservation and enhancement of native natural enemies needs to be evaluated in agroecosystems (Greathead 1991).

Information on the role of natural enemies on population dynamics of *B. tabaci* is limited to a few crops in widely separated geographic locations. In Israel, Horowitz (1986) concluded that natural enemies do not have a major effect on *B. tabaci* populations on cotton. Abiotic factors, e.g., precipitation and extreme relative humidity, assumed to cause high egg and first instar mortality, were the most important factors reducing *B. tabaci* numbers. However, Gerling (1984) had previously pointed out that the regulatory potential of parasitoids attacking *B. tabaci* would only be observed on perennial plants. In Indonesia, parasitism of *B. tabaci* ranging from 0 to 71% was observed in soybeans, but no correlation was found between parasitism and *B. tabaci* density (Kajita et al. 1992). In the same study, mortality factors other than parasitism caused reductions in *B. tabaci* numbers ranging from 0 to 78.6%. In Honduras, Velez (1993) found seven species of parasitoids attacking *B. tabaci* on common beans. *Encarsia pergandiella* Howard and *E. nigricephala* Dozier were the most common parasitoids; no correlation was observed between *B. tabaci* density and percentage parasitism.

The objective of our study was to assess the impact of biological control agents on immature stages of *B. tabaci* infesting two commercial bean varieties grown in Honduras.

<div align="center">MATERIALS AND METHODS</div>

Experimental Design

Field studies were carried out at the Escuela Agrícola Panamericana (EAP), located in central Honduras at approximately 800 meters above sea level. The experiments took place during the 'primera' rainy season (May-August), and the 'postrera' rainy season (September-December), 1995. Planting dates were 9 June and 7 November. Seed, fertilizer, and labor used for the establishment of the plots were provided by the Agronomy Department, EAP. Insecticides and herbicides were not used in the experiments. The total land area used was 3,000 m^2 during 'primera' and 1,600 m^2 during 'postrera'.

The bean varieties used were 'Catrachita' and 'Dorado 364', two commercial bean varieties commonly used in Honduras. 'Dorado' has a bush determinate architecture and is tolerant to the whitefly vectored bean golden mosaic virus (BGMV) (CIAT 1984). 'Catrachita' has a bush indeterminate (semi-climber) architecture, is widely used after corn in relay planting in Honduras, and is susceptible to BGMV. Treatments corresponded to two types of exclusion cages ($1 \times 1 \times 0.5$ m) and a control (no cage). The fine mesh cages (closed) were covered with organdy to exclude most insects.

The coarse mesh cages (open) were covered with a net material (approximately 70 openings per cm^2) that provided exclusion of large insects (e.g., coccinellids and chrysopids) but allowed smaller insects (e.g. aphelinids) to enter the cages. The control was a no-cage treatment that consisted of five bean plants and corresponded to the area covered by the cages (0.5 m^2 or one meter row).

For the 'primera' experiment, the two varieties were randomly assigned to main plots and the three treatments (exclusion cage types) to subplots within the main plots. Each variety and treatment was repeated four times for a total of 8 main plots and 24 subplots. Results from the 'primera' experiment showed that the exclusion of parasitoids was not being accomplished. Thus, field cages were not used in the 'postrera' experiment. In 'postrera', the two varieties were assigned randomly to each of two plots per block in a randomized block design with four repetitions.

Sampling

Field cages were set immediately after the initial whitefly infestation was detected by visual examination of ten trifoliate leaves per plot. This visual sampling was done every two days. Whitefly nymphs were first detected on 18 July. On this date ten leaves per plot were collected, taken to the laboratory and examined under the microscope to quantify initial *B. tabaci* infestation. The cages were placed in the field on 25 July and then sampled every seven days. On each sampling date, five fully-developed trifoliate leaves (one per plant) were collected in paper bags and taken to the laboratory in a cooler. Once in the laboratory, leaves were kept turgid for 3-5 days by placing each leaf petiole into a 3×10 cm glass vial containing tap water. Each glass vial was stopped with cotton and placed in a 2.5 l plastic container (one for each cage) and covered with fine mesh. After three to five days, the leaves were examined under a microscope and the number of nymphs was recorded for each leaf and cage.

The nymphs were classified into five categories based upon their appearance: 1) unparasitized (live) nymphs; 2) parasitized nymphs, in which a parasitoid larva or pupa could be observed; 3) exuviae from eclosed adult *B. tabaci*, showing a 'T' shaped opening; 4) exuviae from eclosed adult parasitoids, showing a circular opening, and 5) dry nymphs, those that seemed preyed upon or did not correspond to any other category. All nymphs corresponding to groups 1 and 2 were placed in glass vials and later dissected to confirm their status.

During 'postrera', sampling was done every seven days and started immediately after initial the whitefly infestation was detected. On each sampling date, ten fully-developed trifoliate leaves per plot (from different plants) were collected in paper bags, taken to the laboratory in a cooler and examined under a microscope. Nymphs were classified based upon their appearance into the categories described for the 'primera' experiment. Leaves infested with live or parasitized nymphs (groups 1 and 2) were kept in 2.5 liter plastic containers. After three to five days, the nymphs were checked again and dissected (when necessary) to confirm their status. Parasitized nymphs were placed in glass vials and kept at room temperature until all the parasitoids had eclosed. All collected parasitoids were cleared in lactophenol and mounted on microscope slides following procedures in Cave (1995). Parasitoids were identified by using keys in Polaszek et al. (1992). Voucher specimens of the parasitoids reared are in the insect collection of the 'Centro de Inventario Agroecológico', Crop Protection Department, EAP.

Data Analysis

The total number of nymphs per leaf was used to compute the percentages for each of the five nymphal categories for each treatment and variety on each sampling date. The percentage parasitism was calculated by adding the percentages of groups 2 (par-

asitized nymphs) and 4 (parasitoid exuviae). The percentages for each of the five groups and the total percentage parasitism for each treatment and variety were transformed using the arcsine transformation [arcsine (proportion)]. The data were analyzed under a split plot design for 'primera' and a completely randomized block design for 'postrera' using an unbalanced analysis of variance (PROC GLM, SAS Institute Inc. 1985). When appropriate, means were separated by using a least significant difference test (LSD). Percent parasitism data from 'primera' and 'postrera' and for each variety were regressed by 1) number of nymphs per leaflet and 2) number of nymphs per trifoliate, to test for host density-dependent parasitism (PROC REG, SAS Institute Inc. 1985). Mean whitefly density estimates (numbers per leaf) for each variety obtained from 18 July sample (before cage set up) were compared using a Students-t test (Ott 1993).

<div align="center">RESULTS</div>

'Primera'

On 18 July there were more *B. tabaci* nymphs per leaf on 'Dorado' (4.5 ± 0.8) (mean $\pm$ SEM) than on 'Catrachita' (2.1 ± 0.3) plots (t = 2.76; df = 4; P = 0.02). This difference, however, was not observed on the subsequent sampling dates (Fig. 1). The percentage of parasitism averaged over three sampling dates was 30.1 ± 2.0 and $24.7 \pm 2.4\%$ for Dorado and 'Catrachita', respectively. Percentage of dry nymphs (those preyed upon or not belonging to other groups) was similar for 'Dorado' ($6.1 \pm 1.1\%$) and 'Catrachita' ($2.9 \pm 0.6\%$).

Significant differences in percentage parasitism were found among treatments (cage types). The open mesh cages (those that provided partial exclusion) had lower parasitism ($20.5 \pm 2.5\%$) than the fine mesh cages and the no-cage treatment (30.2 ± 2.9 and $31.5 \pm 2.4\%$, respectively; F = 4.32; df = 2, 12; P= 0.03) (Table 1 and Fig. 1B). The percentage of adult parasitoid exuviae increased over the sampling dates as the percentage of parasitized nymphs decreased. No differences in percentage parasitism were observed among sampling dates (Table 2).

The predominant parasitoid species collected was *E. pergandiella* (93% of the parasitoids reared, n = 126). The remaining species represented in the samples were *Encarsia porteri* (Mercet) (n = 4), *Encarsia luteola* Howard (n = 1), *E. nigricephala* (n = 1), and *Eretmocerus* sp. (n = 3). The most common predators observed on the bean plants were *Coleomegilla maculata* (DeGeer) and *Nabis* spp.; *Geocoris punctipes* (Say) was also observed on one sampling date.

'Postrera'

The population of *B. tabaci* nymphs was low throughout the 'postrera' 1995 season and never exceeded an average of one nymph per leaf (Fig. 2). No significant differences were observed between bean varieties in the average number of nymphs per leaf or the percentage parasitism (Fig. 2). Parasitism averaged over the sampling dates was 31.2 ± 5.0 % and $23.1 \pm 5.2\%$ for 'Dorado' and 'Catrachita', respectively. The percentage of dry nymphs was 9.9 ± 2.3 and $10.4 \pm 3.4\%$ for Dorado and 'Catrachita', respectively.

The average number of nymphs, and the percentages of dry nymphs and parasitoid exuviae were similar on all sampling dates (Table 3). The percentage of parasitized nymphs was lower on the last sampling date (5 January) than on all previous sampling dates except 15 December (F = 3.53; df = 4, 120) (p = 0.04). The percentage of live nymphs was significantly lower on the first two sampling dates (8 and 15 December) than on the last three sampling dates (21 and 29 December and 5 January)
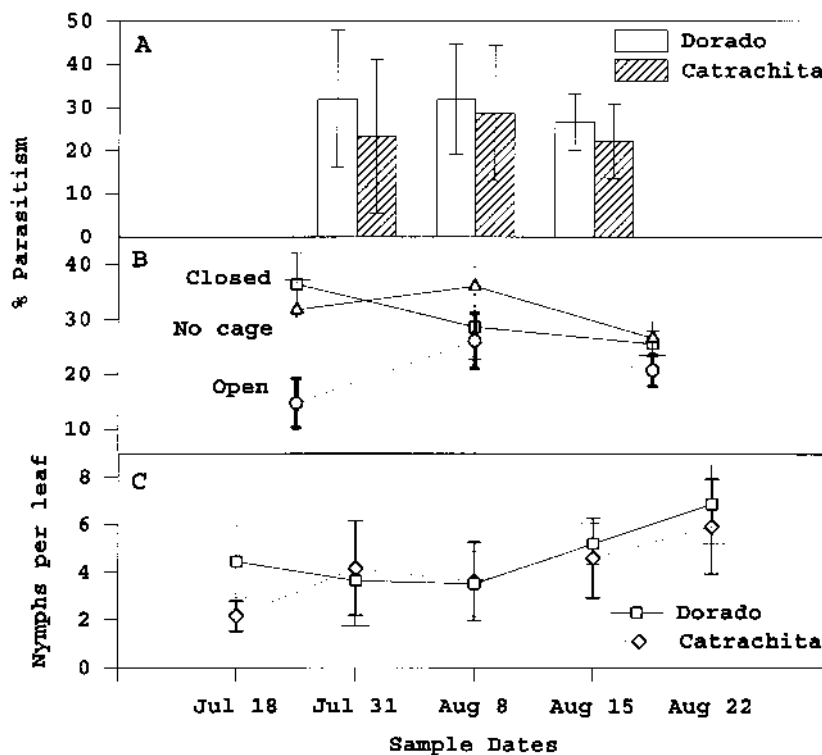
Fig. 1. Percent parasitism (± SD) of *Bemisia tabaci* nymphs in two common bean varieties (A) and two types of exclusion cages and a no cage treatment (B), and average number of nymphs per leaf (± SD) (C) during 'primera' 1995. Fine lines on error bars represent 'Dorado'.

(F = 6.75; df = 4, 12; p = 0.004) (Table 4.). In contrast, the percentage of adult *B. tabaci* eclosed exuviae was significantly higher on the first sampling date (8 December) than on the remaining sampling dates (F = 7.89; df = 4, 12) (p = 0.002) (Table 3).

Percentage parasitism did not change in response to observed fluctuations in a) number of nymphs per leaflet, b) number of nymphs per trifoliate, or c) average number of nymphs per trifoliate in either 'Dorado' or 'Catrachita' (Fig. 3A-C).

The predominant parasitoid species collected were *E. nigricephala* (n = 23) and *E. pergandiella* (n = 12) (40 and 21% of the individuals collected, respectively). The remaining species were *Encarsia hispida* De Santis (n = 11), *E. porteri* (n = 2), *E. luteola* (n = 1) and *Eretmocerus* sp. (n = 8) The most common predators observed on the bean plants were *C. maculata* and *Nabis* spp.

<div align="center">DISCUSSION</div>

Parasitoids and Parasitism

Encarsia pergandiella and *E. nigricephala* were the predominant parasitoids of *B. tabaci* in our study. Both are native species and have been previously reported from

TABLE 1. AVERAGE NUMBER OF *BEMISIA TABACI* NYMPHS PER LEAF; PERCENT PARASIT-
ISM AND PERCENTAGES OF LIVE, PARASITIZED AND DRY NYMPHS, ADULT *B. TABACI* ECLOSED AND ADULT PARASITOID ECLOSED EXUVIAE ON EACH CAGE TYPE; PRIMERA 1995.

	Cage		
Variable	Fine mesh	Open mesh	No Cage
Avg. number of nymphs	4.1 ± 0.4a	3.8 ± 3.4a	4.4 ± 0.3a
Live nymphs (%)	28.5 ± 3.1a	25.9 ± 3.6a	23.8 ± 1.9a
Parasitized nymphs (%)	18.4 ± 3.0a	10.4 ± 1.6a	15.4 ± 2.7a
Adult eclosed exuviae (%)	36.9 ± 3.5a	45.5 ± 4.7a	41.1 ± 2.6a
Parasitoid exuviae (%)	11.8 ± 2.3a	10.3 ± 2.5a	16.2 ± 2.4a
Dry nymphs (%)	4.8 ± 1.4a	4.2 ± 0.1a	4.5 ± 0.1a
Percent parasitism	30.2 ± 2.9a	20.5 ± 2.5b	1.5 ± 2.4a

Numbers followed by the same letter in the same row are not statistically different ($P > 0.05$). Comparisons were made on the transformed data.

Honduras (Velez 1993) and other Latin American countries (Polaszek et al. 1992). *Encarsia pergandiella* is commonly found parasitizing *B. tabaci* on at least 14 wild host species in Honduras (Gomez 1995). In Florida, McAuslane et al. (1993) found *E. nigricephala*, *E. pergandiella*, and *Eretmocerus californicus* Howard commonly attacking *B. tabaci* on peanuts. *Encarsia nigricephala* accounted for 91% of the parasitoids col-

TABLE 2. AVERAGE NUMBER OF *BEMISIA TABACI* NYMPHS PER LEAF; PERCENT PARASIT-
ISM AND PERCENTAGES OF LIVE, PARASITIZED AND DRY NYMPHS, ADULT *B. TABACI* ECLOSED AND ADULT PARASITOID ECLOSED EXUVIAE ON EACH SAM-PLING DATE; PRIMERA 1995.

	Date		
Variable	July 31	Aug. 8	Aug. 15
Avg. number of nymphs	3.9 ± 0.4ab	3.6 ± 0.3b	4.9 ± 0.3a
Live nymphs (%)	25.3 ± 2.9a	30.5 ± 3.3a	22.3 ± 2.6a
Parasitized nymphs (%)	19.0 ± 2.8a	18.1 ± 2.6a	7.2 ± 1.2b
Adult eclosed exuviae (%)	41.6 ± 3.5a	31.4 ± 3.5b	50.5 ± 3.1a
Parasitoid exuviae (%)	8.8 ± 2.2b	12.1 ± 3.0ab	17.2 ± 2.2a
Dry nymphs (%)	5.1 ± 1.4a	5.2 ± 1.1a	3.2 ± 0.7a
Percent parasitism	27.6 ± 3.5a	30.2 ± 2.9a	24.4 ± 1.6a

Numbers followed by the same letter in the same row are not statistically different ($P > 0.05$). Comparisons were made on the transformed data.
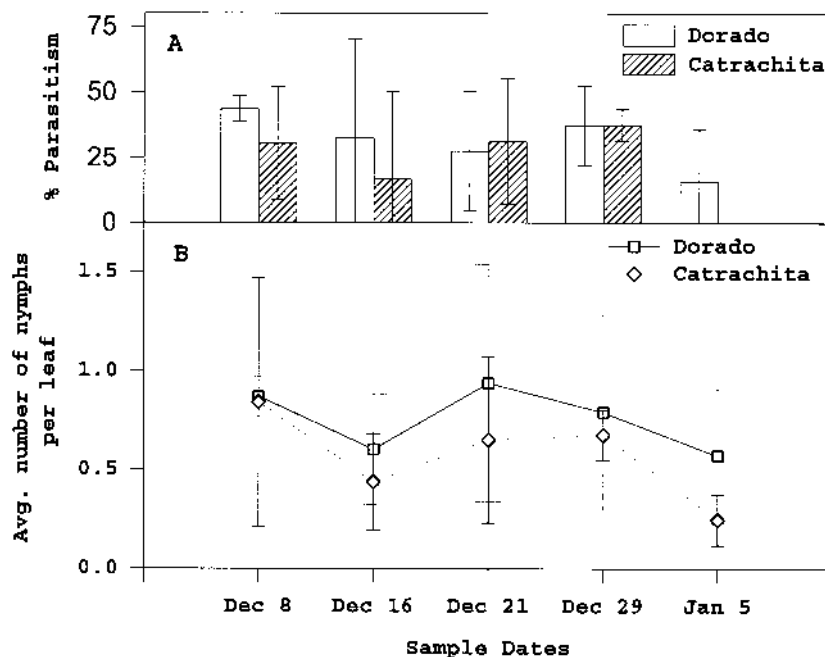
Fig. 2. A, percent parasitism (± SD) and B, average number of *Bemisia tabaci* nymphs per leaf (± SD) on common bean; 'postrera' 1995. Fine lines on error bars represent 'Dorado'.

lected in that study. The distribution and abundance of *E. pergandiella* and *E. nigricephala* reflect their importance as potential biological control agents of *B. tabaci* throughout Latin America and the southern United States.

Velez (1993) found five additional species of parasitoids attacking *B. tabaci* on common bean in Honduras, *Encarsia hispida* De Santis, *E. porteri*, *E. luteola* Howard, *Eretmocerus* sp., and *Amitus* sp. These species were also collected from 14 wild host species in Honduras (Gomez 1995). These same species except *Amitus* sp. were also reared from *B. tabaci* in our study. *Encarsia hispida* is a cosmopolitan species widely distributed in North America (Mexico, California and Florida), Central and South America, and the Caribbean (Polaszek et al. 1992). It was first synonymized with *E. meritoria* by Viggiani (1989) but later treated by Polaszek et al. (1992). Schauff et al. (1996) concluded that the original synonymization was correct and combined the two names. Similar to our study, *Encarsia porteri* accounted for less than 5% of the parasitoids reared by Velez (1993) from *B. tabaci*. Males from this species are facultative-primary egg parasitoids of various species of Lepidoptera (Rojas 1968, Arretz et al. 1985). *Encarsia luteola* is a common species and is widely distributed in the region including Mexico, Brazil, Puerto Rico, and the United States (Polaszek et al. 1992). The species of *Eretmocerus* reared in our study is a native undescribed species (M. Rose, Department of Entomology, Montana State University, personal communication).

The differences in the composition of parasitoid species collected in 'primera' and 'postrera' 1995 may be due to seasonal factors affecting each parasitoid species. Large

TABLE 3. AVERAGE NUMBER OF *BEMISIA TABACI* NYMPHS PER LEAF; PERCENT PARASITISM AND PERCENTAGES OF LIVE, PARASITIZED AND DRY NYMPHS, ADULT *B. TABACI* ECLOSED AND ADULT PARASITOID ECLOSED EXUVIAE ON EACH SAMPLING DATE; POSTRERA 1995.

Variable	Date				
	Dec. 8	Dec. 15	Dec. 21	Dec. 29	Jan. 5
Avg. No. of nymphs	0.9 ± 0.1a	0.5 ± 0.1a	0.8 ± 0.2a	0.8 ± 0.1a	0.4 ± 0.1a
Live nymphs (%)	12.4 ± 4.2b	12.5 ± 8.2b	70.5 ± 17.1a	49.1 ± 6.0a	64.6 ± 11.6a
Parasitized nymphs (%)	31.1 ± 6.2a	18.8 ± 9.7ab	29.4 ± 7.7a	36.3 ± 4.2a	7.9 ± 5.6b
Adult eclosed exuviae (%)	38.9 ± 10.3a	0.0 ± 0.0b	4.9 ± 2.6b	8.0 ± 4.1b	14.1 ± 7.2b
Parasitoid exuviae (%)	5.8 ± 4.7a	5.8 ± 4.2a	0.0 ± 0.0a	8.8 ± 8.8a	0.0 ± 0.0a
Dry nymphs (%)	11.9 ± 4.0a	1.2 ± 7.1a	4.2 ± 3.1a	3.6 ± 2.3a	13.4 ± 5.2a
Percent parasitism	36.7 ± 5.7a	24.5 ± 11.9ab	29.4 ± 7.7ab	37.2 ± 3.8a	7.9 ± 5.6b

Numbers followed by the same letter in the same row are not statistically different ($P > 0.05$).Comparisons were made on the transformed data.
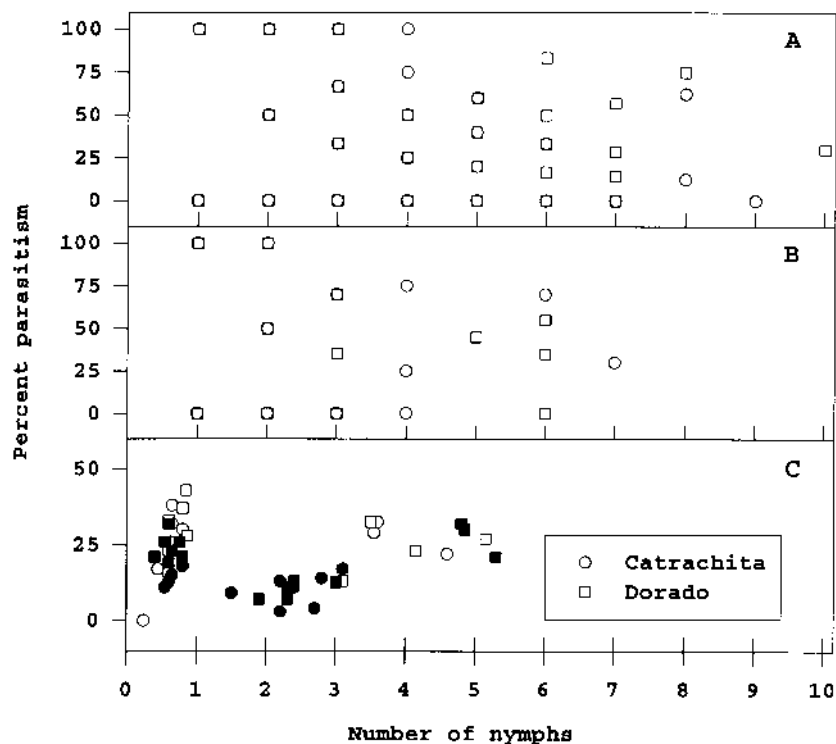
Fig. 3. Relationship between *B. tabaci* nymphal density and percent parasitism on two common bean varieties in Honduras. Square symbols represent 'Dorado'; circles represent 'Catrachita'. A, number of nymphs per leaflet, 'primera' 1995. B, number of nymphs per trifoliate leaf, 'postrera' 1995. C, average number of nymphs per trifoliate leaf, 'primera' and 'postrera', 1995 and Velez (1993). Filled symbols show data from Velez (1993) and open symbols data from this study. Note that the scale on the Y-axis is different in Fig. 3C.

variations in the composition of parasitoids species that attack *B. tabaci* have been observed between seasons at the same localities in Texas (J. Woolley, Department of Entomology, Texas A&M University, personal communication).

The differences in the percentages of the nymphal categories over time may be explained by the aging of the nymphs and parasitoids on the plants. During 'primera' 1995, there was lower parasitism in the open mesh cages compared with fine mesh cages and the no-cage treatment. These results were unexpected. The fine mesh cages did not exclude parasitoids because we were unable to cage naturally infested bean plants before parasitoid colonization. Additionally, parasitoids emerging in the fine mesh cages were unable to escape and may have parasitized the available nymphs, thus increasing levels of parasitism within the cage. The open mesh cages did not prevent parasitoids from entering or escaping, as the closed cages did, but may have deterred parasitoids from entering and attacking susceptible nymphs.

Parasitism levels in our study varied between 8 and 37%. Similar results were obtained by Velez (1993) on the same two bean varieties. These percentages are lower

than other reports from different hosts. In Egypt, parasitism of *B. tabaci* on *Lantana camara* (a perennial plant) fluctuated seasonally and reached 90% from May to October (Hafez et al. 1978). The increase in parasitism coincided with greater host densities. On cotton in California, parasitism by *Eretmocerus* sp. started at low levels but increased following the cessation of insecticide applications, reaching 70% late in the season (Bellows & Arakawa 1988). The increase in parasitism levels were also associated with an increase in *B. tabaci* numbers. These results suggest a density dependent response by the parasitoids to *B. tabaci* densities. Parasitism of *B. tabaci* fourth instars reached 90% on peanuts in Florida at the end of the season, when host densities peaked at 2.4 nymphs per leaflet (5 cm^2) (McAuslane et al. 1994). In our study, average host densities were lower than those found by MacAuslane et al. (1994) and peaked at $\cong$ 0.5 nymphs/5 cm^2 in 'primera' 1995 and $\cong$ 0.1 nymphs/5 cm^2 in 'postrera' 1995. Parasitism levels, however, remained constant over the sampling dates and seasons. This does not indicate a density dependent response by the parasitoids to these relatively low host densities.

To illustrate this point Fig. 4 shows *B. tabaci* nymphal densities and percentage parasitism observed in our study and by Velez (1993). Percentage parasitism did not change in response to changes in number of nymphs per leaflet (Fig. 3A), number of nymphs per trifoliate leaf (Fig. 3B), or the average number of nymphs per trifoliate leaf (Fig. 3C) (r^2 < 0.01, P > 0.5 in each case). Thus parasitoids find and attack a significant percentage of hosts under low host densities indicating their contribution in preventing pest outbreaks of *B. tabaci*.

Predators

The most common predators observed in this study, *C. maculata*, *Nabis* sp., and *G. punctipes*, are generalists. Mortality attributed to unknown factors and predation varied from 3 to 13%. The estimation of predation levels based on nymphal appearance may underestimate predation when predators consume whole individuals and leave no remains on the leaves, as may occur with predators with chewing mouth parts. This indicates the need to develop better methods to document predation of *B. tabaci*. Hagler et al. (1993) have developed a monoclonal antibody to test predators for consumption of *B. tabaci* and demonstrated their use in the field (Hagler & Naranjo 1994).

Biological Control of *B. tabaci* on Common Bean

Integrated pest management programs are needed that enhance the impact of native natural enemies on pest populations in the tropics (see Greathead 1991). Beans are grown under many different cropping systems in Honduras, reflecting local variations in climatic and socioeconomic factors (Woolley et al. 1991). In most of these systems, however, plant resistance can provide an economical method of disease control and will be the basis for the management of *B. tabaci* and its vectored viruses including BGMV (Galvez & Cardenas 1980). Plant resistance provides a basis for the integration of other tactics such as biological control and cultural control into integrated pest management programs. The effectiveness of cultural practices, such as changing planting dates to 'escape' high infestation levels can be enhanced by selecting short cycle tolerant varieties such as 'Dorado' (CIAT 1984). In our study, 'Dorado' appeared to have a slight advantage over 'Catrachita' in the percentage parasitism harbored under similar whitefly pressures. Even though this advantage was not statistically significant, it may be biologically important. By harboring low to moderate levels of

hosts or prey, tolerant varieties such as 'Dorado' can support natural enemy populations for enhanced suppression of *B. tabaci* populations.

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