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IMPACT OF THE RED IMPORTED FIRE ANT ON PREDATORS, APHIDS AND EGGS OF BOLLWORM AND BEET ARMYWORM IN COTTON IN TEXAS

Rodrigo Diaz, Allen Knutson, and Julio Bernal
Entomology Department
Texas A&M University
College Station, TX

Abstract

The effects of the Red Imported Fire Ant, *Solenopsis invicta* (Buren) (IFA hereafter), on common predators, cotton aphid populations, and its predation on eggs of bollworm (*Helicoverpa zea* Boddie) and beet armyworm (*Spodoptera exigua* Hubner) were evaluated under field conditions in central Texas. Fire ants were excluded from large field plots using selective insecticidal baits while adjacent plots were left untreated. Cotton aphid populations were ca. 5.5 times higher in plots with ants versus plots without ants, but did not reach the economic threshold. Densities of convergent lady beetles were greater in the presence of IFA because they respond to the greater density of cotton aphids, which were tended by IFA. Densities of minute pirate bugs, spiders and lacewing were less in the presence of IFA. Predation of sentinel bollworm eggs, indicated by their absence after 24 h, was two times higher in plots with ants versus plots without ants. Most predation of sentinel beet armyworm egg masses, measured via direct nocturnal observations, was due to IFA (68%) and cotton fleahoppers [*Pseudatomoscelis seriatus* (Reuter)] (21%) in plots with ants, and by the mite *Abrolophus* sp. (52%), spiders (13%) and minute pirate bug (*Orius* sp.) in plots without ants. The results of this study show that while IFA promote aphid populations early in the growing season, fire ants significantly increase the predation of bollworm and beet armyworm eggs by the total predator complex.

Introduction

The Red Imported Fire Ant, *Solenopsis invicta* (Buren) (IFA hereafter), arrived in the USA between 1933 and 1945 from Brazil (Callcott and Collins 1996) and currently is found in ca. 118 M ha in the southern states (USDA, APHIS, 1996). Among the biological factors facilitating range expansion of IFA are mass foraging, a venomous sting, territoriality, large colony size, and alate dispersal (Showler and Reagan 1987). Within the range of IFA, it is among the key insect predators present in cotton (Sterling et al. 1979), and according to Lopez et al. (1996) may be the most important fire ant species in USA cotton agroecosystems because of its distribution, abundance, and predatory aggressiveness. Cotton fields are colonized by foraging workers from colonies outside cotton fields and by new immigrant queens after mating flights (Lopez et al. 1996).

Impacts of IFA on cotton insect diversity are of particular interest if populations of predators and parasitoids of cotton pests are reduced. Lofgren (1986) provides a list of reports of predation on beneficial insects by IFA in different crops, and Vinson (1994) provides a review of predation by IFA in different ecosystems. Using D-Vac samples and pitfall traps, Sterling et al. (1979) found that IFA did not negatively affect populations of predators in east Texas cotton. However, Reilly and Sterling (1983) found positive relationships between numbers of IFA foragers and cotton aphids (*Aphis gossypii* Glover), damsel bug (Nabis spp.), cotton fleahopper [*Pseudatomoscelis seriatus* (Reuter)] and minute pirate bug (*Orius* spp.), and concluded that IFA might eliminate cues such as exuvia, excreta and honeydew used by natural enemies of these species. More recently, Eubanks (2001) found that densities of IFA foragers had a negative correlation with all 16 herbivores and 22 of 24 natural enemies encountered in cotton and soybean fields during the entire season.

Aphis gossypii Glover is the most common aphid pest occurring on cotton in the United States. According to Henneberry et al. (2000) damage is due to direct feeding on leaves which reduces yield, contamination of lint by honeydew and growth of associated fungi, and transmission of more than 50 plant viruses. IFA is known to interact with cotton aphids. For example, Reilly and Sterling (1983) found a highly positive association between cotton aphids and IFA in east Texas cotton field. Other observations suggest that fire ants tend cotton aphids on cotton early in the growing season (Sterling et al. 1979).

IFA is also known to prey on eggs and larvae of lepidopteran insects in agricultural landscapes, including pests species such as bollworm [*Helicoverpa zea* (Boddie)], tobacco budworm [*Heliothis virescens* (F.)], velvetbean caterpillar (*Anticarsia gemmatalis* Hubner) and soybean looper [*Pseudoplusia includens* (Walker)] (Lofgren 1986). Furthermore, in Louisiana management of sugarcane borer (*Diatraea saccharalis* Fabricius) partially depends on the predatory activity of IFA (Reagan 1981). Using radioactive tagged eggs, McDaniel and Sterling (1979, 1982) found that IFA is the most common predator of tobacco budworm eggs on cotton plants in East Texas cotton and IFA preyed on third and fourth instar larvae. Nuessly and Sterling (1994) found that IFA is responsible for 86% of egg mortality attributable to specific arthropods.

The objectives of this research were to assess the influence of IFA on common predators, cotton aphid population dynamics, and evaluate their importance as predators of bollworm and beet armyworm. Weekly samples of predators, aphid populations, reports of presence or absence of sentinel eggs and nocturnal observations of predation accomplished these objectives.

Materials and Methods

The study was conducted in a cotton field on the Texas A&M Stiles Farm Foundation in Williamson County, TX. The cotton variety was Deltapine 436 RR (DP & L Co., Scott, MS). Eight plots of three ha each and arranged in two rows of four plots were located in the center of a ca. 60 acres cotton field. Four alternating plots were treated with broadcast applications of Extinguish and Amdro fire ant baits in spring 2001 to eliminate ants present in each plot (plots without IFA). The effective sampling area consisted of a square of 25m by 25m in the center of each plot, and foliar insecticides were not applied in this area. The remaining four plots were left untreated and served as controls (plots with IFA). Fire ants foraging in the plots were sampled weekly using vials baited with candy and cat food.

Ten species of canopy-dwelling predators were sampled weekly from June to August using the beat bucket technique, which consists of shaking cotton plants inside a 5-gallon white plastic bucket and counting all recovered predatory insects (Knutson and Wilson 1999). Fifteen stations located in a diagonal transect were sampled inside the sample area of each plot. At each station, a sample of three consecutive plants was taken early in the morning (8:00-10:00 am). Predators that were recorded included minute pirate bug, cotton fleahopper, red imported fire ant, crab spider, jumping spider, other spiders, bigeyed bug, green lacewing, lady beetle, damsel bug, and Scymnus spp.

Cotton aphid populations were visually sampled from June to August using the key leaf technique (Hardee et al. 1994). Each plot was sampled in 10 stations, starting in one corner of the sample area and crossing diagonally to the opposite corner. Each station consisted of five consecutive plants.

Twenty-five bollworm eggs one-two days old were placed per day, one per terminal leaf of 25 plants, in each plot; therefore, each treatment had 100 eggs. Plants with sentinel eggs were in a single row and separated at least by two meters from each other. Each egg was handled using a fine brush and glued to leaves with gum arabic. Presence or absence of eggs was recorded after 24 hours. The proportion of eggs that disappeared after 24 hours was arcsine transformed. This experiment was repeated on 18 different days during mid and late season.

Night observations were conducted in order to determine predatory species and timing of predation events on lepidopteran eggs. Egg masses of beet armyworm [*Spodoptera exigua* (Hubner)] with ca. 40-50 eggs each and individual eggs of bollworm were placed in two different but adjacent plants. Paper slips with an egg mass was handled using forceps and glued to a leaf with Elmer's glue. This experiment started between 6:00 to 7:00 pm. Each plant was observed for a period of 5 seconds every 15 minutes. Predators feeding on the eggs were identified to genus level in the field, and the numbers and time of predatory events were scored for a period between 7:00 pm and 1:00 am. A predatory event was established when a predator was eating/removing an egg. This experiment was repeated three times in each treatment.

Results and Discussion

Insecticide bait treatments were very effective in eliminating fire ants in the treated plots as determined by bait vial samples. Fire ants were collected in the bait vials on only three of the eight sample dates and mean number of ants per vial was less than five compared to a mean of 55-65 ants per vial in the untreated check.

Cotton aphid densities were significantly higher in plots with ants vs. plots without ants. Most of the increase was early in the season and aphid densities in the presence of fire ants declined as densities of lady beetles dramatically increased. As a result, aphid densities did not reach the threshold level for insecticide application of 50 aphids/leaf.

Densities of convergent lady beetles were significantly higher early in the season in plots with IFA compared to plots without IFA due to the greater number of aphids in plots with fire ants. Densities of *Orius* spp., lacewing larvae and spiders were significantly less in plots with IFA. Bigeyed bug densities were significantly greater in plots with IFA. Densities of damsel bugs were not different.

Although the presence of IFA was associated with a decline in densities of some important predators, results on bollworm egg predation indicate the additional predation provided by IFA exceeded the loss of predation due to that provided by the suppressed species. Predation and removal of bollworm eggs during 24 hours was significantly greater in plots with IFA (58 %) than in plots without IFA (28 %) on 14 of the 18 study dates.

Forty-seven predation events on beet armyworm egg masses were witnessed in plots with ants vs. sixty-nine events in plots without ants during 18 hr of observations. In plots with ants, IFA and cotton fleahopper were the most commonly observed predator of beet armyworm egg masses. In plots without ants, the most frequently observed predators of beet armyworm eggs was a mite, *Abrolophus* sp. (Acari: Erythraeidae), spiders, cotton fleahopper and minute pirate bug. Red imported fire ants recruited workers which often removed all eggs in the mass in ca. 30-40 min. In contrast, the mite *Abrolophus* sp. consumed one-two beet armyworm eggs during ca. 2 hr. These results suggest that IFA is the most frequent predator of bollworm and beet armyworm eggs due to mass foraging, recruitment and aggressive behavior.

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