Economic Aspects of the Imported Fire Ant in the United States

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Two species of imported fire ants (IFA), *Solenopsis invicta* and *S. richteri*, were accidentally transported to the United States in the early 1900's. Their spread from the initial point of introduction, (Mobile, Alabama) was rapid and enhanced by concealment of newly-mated queens or young colonies in nursery stock. Currently, they are estimated to infest more than 9.3×10^7 ha (2.3×10^8 acres) in nine southern states and Puerto Rico.

The economic impact of the IFA has been a subject of much discussion. Generally, they have been classified as nuisance pests because of their mound-building and stinging habits (Lofgren et al. 1975); however, documentation of the problems they cause is meagre and based primarily on survey reports rather than experimentation. Consequently, we began studies several years ago on the impact of IFA on man and his crops and domestic animals. We concentrated our efforts on their effect on public health and the production of soybeans. Other studies included the interrelationship of IFA with sugarcane, okra and various vegetable crops, but these will not be discussed in this report.

Public Health Impact

The impact of IFA on man has been the subject of a number of investigations which have centered on systemic allergic reactions to the venom. The literature was reviewed by Lockey (1974) who gave a good description of the sequence of events that result from an imported fire ant sting. The initial reaction is a burning sensation which is followed by the formation of a wheal which may become as large as 10 mm in diameter. Typically, a small vesicle containing clear fluid forms at the sight of the sting after about 4 hours. The vesicle becomes cloudy and a white pustule forms, usually after about 24 hrs. The pustule may remain from a few days to as much as a week before rupturing and often, especially in older persons, a small scar may remain at the sting site for a few weeks to several months. Secondary infections may occur if the pustule is broken. This is a special problem for laborers, farmhands and others who may not adequately protect the exposed area.

While the venom of the imported fire ant is composed primarily

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of alkaloids (2,6 disubstituted piperidines; MacConnell et al. 1970), it does contain a small aqueous component (less than 5 percent) in which Baer et al. (1979) demonstrated the presence of 3 allergenic proteins. Susceptible individuals require immediate medical attention and deaths have been reported.

The only recorded attempt to correlate the incidence of allergic systemic reactions within known populations was made by Rhoades et al. (1977) in Jacksonville, Florida. This city was serviced by only 2 allergists who reported 21 new cases of allergy to fire ant venom in a population area of 560,000, an incidence rate of 3.8 per 100,000 per year. They considered that these figures only "scratched" the surface since some patients probably reported to emergency rooms and others may have had reactions that were not diagnosed.

Using the previous incidence rate, we computed a minimum estimate of the total number of individuals that may become sensitized to IFA venom each year. According to the 1980 census, approximately 38.4 million people live within the 9 infested states. At the rate of 3.8 per 100,000, at least 1460 new cases could be expected yearly. While there is no manner in which we can estimate the total expenses that might be incurred by persons sensitized to IFA venom, we were able to obtain the following data on the cost of hyposensitization therapy at the J. Hillis Miller Health Center, Gainesville, Florida (H. J. Wittig, personal communication) for the year 1978. Cost of the initial patient evaluation was $60.00 while follow-up consultations cost $45.00. Total cost of injection materials was $36.00. Based on these data the cost of desensitizing 1460 new patients each year would be $205,860.

While systemic allergic reactions pose the greatest danger from IFA attacks, many lesser primary or secondary reactions may require medical treatment. Data from several studies are available now from which we can make estimates. Clemmer and Serfling (1975) surveyed a total of 240 households (777 persons) by telephone in Metarie, Lousiana. Sting attacks were reported for 29% of the persons during the months of June-August, 1973 and 1.3% required medical consultation.

We collaborated with health officials in two counties in Georgia to conduct similar surveys. In Lowndes County, Georgia (Yeager, 1978) a sampling of 156 families, including equal numbers of urban and rural residents, revealed that 1 out of every 5 residents could expect to be stung each month and less than 5% of those stung required medical care. The second study (Adams and Lofgren, 1981) was conducted in Sumter County, Georgia in a predominately rural area. A total of 213 sting attacks were reported during one year (1976) on 95 of 272 survey participants (35%). Two individuals (1%) classified their sting reaction as severe, 26 (12%) as moderate and 183 (87%) as mild.

Adams and Lofgren (1982) reviewed data on patients reporting for medical treatment for arthropod sting/bite attacks at Ft. Stewart, Georgia. IFA were responsible for 161 (49%) of a total of 329 patients treated from April 1 to September 30, 1979. This represents 0.7% of the post population including military personnel (12,000) and dependents (11,000). Only 7% of the sting attacks were caused

by bees and wasps. Eight persons (5%) exhibited symtoms of shock due to IFA stings and 11 (7%) developed secondary infections. Five patients were hospitalized for 1 day each. Direct medical cost for outpatient visits was $23.10 while the cost of hospitalization was $176.45 per day. Total estimated cost attributable to IFA was $5,070.

For purposes of calculating potential medical costs for the 38.4 million people living in the IFA-infested area, we averaged the sting rates for the studies by Clemmer and Serfling (1975) and Adams and Lofgren (1981) to obtain an average sting attack rate of 32%. Also, we averaged the percent of persons requesting medical treatment in the Clemmer and Serfling (1975) study (1.3%) and the percent of the Ft. Stewart population reporting to the dispensary for treatment of IFA stings (0.7%) to obtain a medical treatment rate of 1.0%. Based on these data, the annual cost for medical treatment (one office visit per patient at $23.10) would be approximately 2.84 million dollars ($38.4 \times 10^6 \times 0.32 \times 0.01 \times \$23.10$).

Agricultural Impact

In 1949 Wilson and Eads (1949) conducted a survey on the economics of the IFA for the Alabama Department of Conservation in the main infested areas at that time (Mobile, Baldwin and Washington Counties, Alabama). They concluded from their systematic poll of 174 farmers that IFA were a major crop pest. Primary damage was attributed to feeding on the seeds or seedlings of crops such as corn, peanuts, beans, potatoes and cabbage. Following their survey, complaints of damage to crops by IFA decreased and as recently as 1976 a report published by the Council for Agricultural Science and Technology (Anonymous, 1976) stated that they were not a major pest of crops.

However, an important development that coincided with the apparent decrease in economic importance of IFA in the 1950's was the advent and wide-scale use by farmers of chlorinated hydrocarbon pesticides (dieldrin, heptachlor, chlordane) for control of numerous soil insect pests. In addition federal-state supported programs for control of white-fringed beetles, *Graphognathus* spp., resulted in the application of these insecticides to many cultivated fields. Since these pesticides are extremely effective residual chemicals they also controlled IFA and thus, indirectly reduced the importance of IFA as crop pests. However, after registrations for use of these chemicals on cropland were withdrawn by the Environmental Protection Agency about 1970, we suspected that IFA might become a major crop pest once again. This conclusion, as well as complaints from farmers in Georgia in the mid-1970's about IFA interfering with soybean harvest, prompted us to initiate a series of studies on interactions between IFA and various crops.

Our initial research was directed toward the impact and interference of IFA mounds with harvesting of soybeans. Soybean plants develop pods over the entire plant thus the plant must be cut close to ground level to harvest all of the soybeans. Consequently, IFA mounds only a few inches high interfere with harvest of soybeans. If the combine operator raises the header bar to avoid the mound and protect his equipment, a large amount of beans on the lower portion

of the plant are missed, if the operators choose not to raise the header bar, plants ahead of the mound are pushed over with soil. Also, soil taken into the combine increases wear and damage to the equipment. We conducted two studies to evaluate the impact of IFA mounds on soybean harvest. The first study near Valdosta, Georgia (Adams et al. 1976) revealed a loss of about 0.22 hl/ha or $6.00/ha in a field with an infestation of 109 mounds/ha. The second study in southeastern North Carolina (Adams et al. 1977) showed a loss of 0.64 hl/ha or $12.35/ha (140 mounds/ha). Considerable undetermined expenses resulted from damage to harvesting equipment.

While conducting the prior tests we noted that total yield of soybeans indicated a greater loss than could be attributed to the incomplete harvest caused by the mounds. Consequently, we conducted additional tests in which fields were divided and one-half was treated with mirex bait to eliminate IFA while the other half remained untreated. A summation of all of our data (Lofgren and Adams, 1981) showed an average decrease in yield for 8 paired fields of 14.5% or 5.1 hl/ha with infestation rates of 49 to 176 mounds per ha.

Because of this significant loss of soybeans we planned further tests in Florida, Mississippi, and North Carolina. Preliminary evaluation of the data from this research confirms the prior results. The tests at Gainesville show a reduction in yield of 7 hl/ha (99 mounds/ha) while those in Mississippi (W. A. Banks, unpublished data) show a loss of 5.2 hl/ha (160 mounds/ha). The North Carolina tests (C.H. Apperson, unpublished data) revealed that plant stand, plant height and IFA were negatively correlated with yield and that a regression analysis of IFA against yield indicated a 5.2 to 8.7 hl/ha reduction where ant activity was high compared to where it was low.

Additional observations in our tests suggested that yield reductions were associated with feeding on germinating seeds, since plant stand was reduced from 40.7 to 26.2 plants per row meter in the check plots and IFA-infested plots, respectively. Damage to the growing plants probably occurred also, since a high percentage of ants foraging near plants injected with ^{32}P were found to contain radioactivity.

An estimated 5,557,085 ha were planted with soybeans in the 7 most heavily infested states in 1981. (Southeastern Farm Press, Inc. Clarksdale MS; Vol. 8(45)) If we assume that (1) 25% of the land in these states is heavily infested, (2) the average reduction in yield is 5.2 hl/ha and (3) the sale price of soybeans is $17.00 per hl, then in 1981 about 7,254,000 hl of soybeans were lost to IFA with a value of almost $125,000,000.

Our observations confirm the study by Wilson and Eads (1949) that IFA feed on and destroy germinating soybean seeds or seedlings and that they are a major pest of soybeans. One reason for the susceptibility of soybeans may be that they are normally planted in late spring or early summer. At this time of year the IFA are actively producing sexual and worker brood and require large amounts of food. Also, rainfall in the southeastern U.S. is limited during April and May or until the summer thundershowers begin. Both of these conditions could create a critical food stress situation for IFA in newly cultivated and planted fields and thus germinating

soybean seeds would provide a ready source of food and water. Crops such as cotton, corn and peanuts that are planted earlier in the year (February to April) before ant activity reaches its peak may not be as susceptible to attack. It is obvious that much more research will be required to assess the economic impact of IFA on soybeans as well as numerous other agricultural crops.

References

Adams, C. T. and C. S. Lofgren. 1981.Red imported fire ants (Hymenoptera: Formicidae): Frequency of sting attacks on residents of Sumter County, Georgia. J. Med. Entomol. 18: 376-380.

Adams, C. T. and C. S. Lofgren. (In press).--Incidence of stings or bites of the red imported fire ant and other arthropods among patients requesting medical treatment at Ft. Stewart, Georgia. J. Med. Entomol.

Adams, C. T., J. K. Plumley, W. A. Banks and C. S. Lofgren. 1977. Impact of the red imported fire ant, *Solenopsis invicta* Buren (Hymenoptera: Formicidae), on harvest of soybeans in North Carolina. J. Elisha Mitchell Sci. Soc. 93: 150-2.

Adams, C. T., J. K. Plumley, C. S. Lofgren and W. A. Banks. 1976.--Economic importance of the red imported fire ant, *Solenopsis invicta* Buren. I. Preliminary investigations of impact on soybean harvest. J. Georgia Entomol. Soc. 11: 165-9.

Anonymous. 1976.--Fire ant control. Council for Agricultural Science and Technology. CAST Report No. 62; 2nd Ed. Rep. No. 65. 24pp. Iowa State Univ.

Baer, H. T. Y. Liu, M. C. Anderson, M. Blum, W. H. Schmid and F. J. James. 1979.--Protein components of fire ant venom (*Solenopsis invicta*). Toxicon 10: 259-71.

Clemmer, D. L. and R. E. Serfling. 1975.--The imported fire ant: Dimensions of the urban problem. South. Med. J. 68: 1133-38.

Lockey, R. L. 1974.--Systemic reactions to stinging ants. J. Allergy Clin. Immunol. 54: 132-46.

Lofgren, C. S. and C. T. Adams. 1981.--Reduced yield of soybeans in fields infested with the red imported fire ant, *Solenopsis invicta* Buren. The Fla. Entomol. 64: 199-202.

Lofgren, C. S., W. A. Banks and B. M. Glancey. 1975. Biology and control of imported fire ants. Annu. Rev. Entomol. 20: 1-30.

MacConnell, J. G., M. S. Blum and H. M. Fales. 1970.--Alkaloid from fire ant venom: Identification and synthesis. Science 168: 840.

Rhoades, R. B., W. L. Shaeffer, M. Newman, R. Lockey, R. M. Dozier, P. F. Wubbena, A. W. Townes, W. H. Schmid. G. Neder, T. Brill and H. J. Wittig. 1977.--Hypersensitivity to the imported fire and in Florida: A report of 104 cases. J. Fla. Med. Assoc. 64: 247-54.

Wilson, E. O. and J. H. Eads. 1949.--A report on the imported fire ant, *Solenopsis saevissima* var. *richteri*, in Alabama. Spec. Rep. Ala. Dep. Conserv. Mimeo. 54pp.

Yeager, W. 1978.--Frequency of fire ant stinging in Lowndes County, Georgia. J. Med. Assoc. Ga. 2: 101-2.